There are peace time uses for mathematics far more numerous and useful than those of war. In preparation for our part in the affairs of the new day, let us have more and better mathematics.—WALTER H. CARNAHAN.

CONTENTS FOR FEBRUARY, 1945

A Few Words From Me to You—*Walter H. Carnahan* 99

Professor H. C. Christofferson, New Mathematics Editor 100

Elliot Rowland Downing—*W. L. Beauchamp, O. D. Frank, John C. Mayfield* 101

John Charles Hessler—*Glen W. Warner* 103

Alfred C. Field—*W. F. Willard* 104

Science and Mathematics in Army Service—*Captain Daniel C. McNaughton* 105

The Chemist in the Petroleum Industry—*Gustav Egloff* 112

Those Drugs of Ours—*Frederick F. Yonkman* 118

Mathematics and Science in a Liberal Education—*Mark H. Ingraham* 128

Aircraft Instrumentation—*W. W. Davies* 136

Selling Mathematics—*Walter H. Carnahan* 148

Radio in Post-War Education—*Nathan A. Neal* 154

Sine Curves—*A. R. Jerbert* 168

Notes From a Mathematics Classroom—*Joseph A. Nyberg* 173

Central Association of Science and Mathematics Teachers—*Harold H. Metcalf* 177

Problem Department—*G. H. Jamison* 191

Books and Pamphlets Received 194

Book Reviews 196

MODERN WORKBOOKS
for
All Your Science Courses

Trafton-Smith: GENERAL SCIENCE WORKBOOK . . . . . **$1.00 list**

Vance-Barker-Miller: BIOLOGY WORKBOOK . . **$1.20 list**

Carpenter-Carleton: COMPREHENSIVE UNITS IN CHEMISTRY . . . . . **$1.20 list**

Buell-Schuler: PHYSICS WORKBOOK . . . . . **$1.20 list**

Each workbook is organized to be used with any standard high school text. Each is complete with tests, problems, exercises, and experiments.

Write for further information or examination copies

J. B. LIPPINCOTT COMPANY

Chicago Philadelphia New York

Short Course in **Computation**

♦ Principles of Arithmetic, Practice, Diagnostic Tests, and Remedial Exercises

Clifford B. Upton

Through a careful explanation of all difficult processes, problems, tests, and remedial exercises, this book provides the grounding necessary to the pursuance of all work in aviation, business, or general use. 176 pages, 56¢

Air Navigation Workbook

♦ A Course in Graphic Mathematics

A. D. Bradley, Lt. (jg) U.S.N.R. and Clifford B. Upton

This introductory course consists mainly of making scale drawings. Space is provided and a special protractor and scales are furnished. The clear, non-technical language requires no special training in air navigation. 112 pages, 88¢

Mathematics of Air and Marine Navigation

♦ With Tables

A. D. Bradley, Lt. (jg) U.S.N.R.

This text contains the mathematical theory necessary to the navigator of air and surface vessels. Haversines are used to simplify formulas and computations. Plane trigonometry is prerequisite. 158 pp., $1.00

American Book Company

SCHOOL SCIENCE AND MATHEMATICS

VOL. XLV FEBRUARY, 1945 WHOLE NO. 391

A FEW WORDS FROM ME TO YOU

WALTER H. CARNAHAN

President of the Central Association of Science and Mathematics Teachers

Let us all heartily congratulate Mr. Massey, our retiring president, on a job well done, under especially difficult circumstances. He had an excellent program and had made good plans. It was certainly no fault of his nor of any responsible persons connected with the management that the International Conference on air planning chose to stay on in rooms on which we had counted. It was a bad break for our convention, but we had a good meeting in spite of the inconvenience. And that fact is an indication of the solidity of our great organization.

As members of The Central Association of Mathematics and Science teachers we cannot go into retirement until November of 1945. We must be active the year round if the organization is to maintain its strength. This applies not only to the officers but to all members as well. Long ago this Association outgrew the condition which might have prevailed once upon a time (or could it have done so?) when a few persons could do most of the planning and execution. We are now big and full grown and there is constant responsibility for us all.

Your elected officers have already begun plans for the coming year and for the events in November which are the culmination of the activities of this period. We are giving thought to the program, to the place of meeting, to hotel accommodations, to travel accommodations and other details connected with the November meeting. As good school people, will each of you take this home work assignment: Take a little time to think about

our problems and their reasonable solution, then write one of the members of the Board of Directors or to some other officer and make your suggestions. We want your suggestions as to talent for the various programs, good material for officers for another year, ideas for general improvement. You will understand that not every good idea submitted can be used because of limitations under which your officers must operate, but all suggestions will receive grateful consideration.

There is one very valuable part of the Association program that directly depends upon you and me as ordinary members, and that is the personal contacts, the conversations, the hand shakes, the smiles, the luncheon groups, the professional exchanges. Our organization has long been outstanding for these manifestations of friendliness. Resolve now to take full advantage of personal contacts this year and make a large contribution of your own. That is the way Central Association grows and finds its place in the lives of more and more teachers.

PROFESSOR H. C. CHRISTOFFERSON, NEW MATHEMATICS EDITOR

In November 1924 Dr. Jacob M. Kinney's name first appeared as the Mathematics Editor for this journal. For over twenty years he has faithfully and carefully edited many of the articles for our mathematics readers. Now he wants to spend his time with his mathematics texts and agricultural interests. We regret to lose him but wish him continued success and many happy and useful years.

Doctor H. C. Christofferson, Director of Secondary Education and Professor of Mathematics at Miami University now takes over the work of Dr. Kinney. Mr. Christofferson needs no introduction to mathematicians and mathematics teachers. From 1936 to 1938 he served as Director of the National Council of Teachers of Mathematics and was the President of that organization from 1938 to 1940. Educationally he is the product of three of our great universities, having received the B.A. degree from the University of Minnesota, the M.A. from the University of Chicago, and the Ph.D. from Columbia. His honors include Phi Beta Kappa, Phi Delta Kappa, and Kappa Delta Pi. He has had experience as a high school teacher, principal and superintendent, a college teacher of mathematics and the teach-

ing of mathematics, and is the Director of Secondary Education at Miami University.

He is the author of *Geometry Professionalized for Teachers*, several workbooks, the Mathematics Tests in Ohio Scholarship Tests for several years, and several State Bulletins. He has been a frequent contributor to SCHOOL SCIENCE AND MATHEMATICS and *The Mathematics Teacher* and has written occasionally for the *Educational Forum* and the *Journal of Educational Research*. In the various national and state organizations he is well known, serving on the Board of Directors of the Central Association of Science and Mathematics Teachers from 1942 to 1944. From 1941 to 1943 he was Educational Consultant for the Civil Aeronautics Administration in Ohio. He is a member of the National Education Association, the American Mathematical Association, the American Educational Research Association and State and Regional mathematics organizations.

ELLIOT ROWLAND DOWNING
1868–1944

The death of Dr. E. R. Downing occurred at the Downing home in Williams Bay, Wisconsin, on September 10, 1944. The immediate cause of his death was coronary disease. In his passing the field of science education has lost one of its well-known leaders.

Dr. Downing was born in Chelsea, Mass., but spent most of his life in the Middle West. Work for his doctor's degree in zoology was done at the University of Chicago prior to 1901. Later he studied at Columbia University and at the Naples Aquarium of the University of Wurzburg. Among other places he taught at Beloit College, Wisconsin, and the Northern State Normal School at Marquette, Michigan, before taking up the work at the University of Chicago for which he is best known. From 1911 to 1934 hundreds of science teachers were trained in his classes and many of them did research in science education under his direction. He was an active member of organizations of scientists, educators and science teachers. In 1925 he was president of the Central Association of Science and Mathematics Teachers and later served as a director. For a number of years he edited the *Nature Study Review*.

As a regular contributor to scientific and educational maga-

zines Dr. Downing published twenty-six articles in this journal. Beginning in 1918 he published a variety of books for teachers and pupils. Among the best-known of these are *Our Living World, A Naturalist in the Great Lakes Region, Science in the Service of Health,* and *An Introduction to the Teaching of Science.*

In spite of the handicap of a serious major operation and slow recovery, Dr. Downing continued his activities in science education after his retirement in 1934. He was one of the organizers and staff members of the Lake Geneva School of Natural Science from 1936 to 1941. He was co-author of a high school biology textbook, *Living Things and You,* published in 1940.

As a young man Dr. Drowning spent much of his leisure time in the outdoors. Deeply religious, he found in the natural world the laws and the will of the Creator and became convinced that man must work with and through these laws if he is to survive and make progress either as an individual or as a species. From research and teaching in the content of biology his interests gradually shifted to science education and science teachers through whom developing boys and girls could be led to understand and use the laws of nature.

Professor Downing was one of the earliest and most persistent proponents of the organization of teaching units about important science principles, of requiring the use of such principles in solving every-day problems until they became a part of the thought and life of the pupil. He believed that the scientific attitude and scientific methods of thinking could be and should be taught in science courses. Largely through his efforts these emphases pervaded the *Thirty-First Yearbook* of the National Society for the Study of Education ("A Program for Teaching Science") and came to be regarded by many as essential criteria of good textbooks and good science teaching.

Professor Downing was always kind, friendly and generous. Those who came really to know him found sterling character, quiet strength and steady inspiration. He exacted of himself the same thorough and honest workmanship that he expected from his students. His fine spirit lives on in the hearts and work of those who were privileged to know him.

W. L. Beauchamp
O. D. Frank
John C. Mayfield
The University of Chicago

JOHN CHARLES HESSLER
1869–1944

The death of Dr. John Charles Hessler, President of James Millikin University, Decatur, Illinois, on July 29, 1944 closes the career of one of Illinois' greatest educators. He was born in Syracuse, New York, Nov. 27, 1869. Coming to Chicago early in life he began his teaching career in 1890 at the old Lake High School and later transferred to Hyde Park. Along with teaching he continued his college education and received the A.B. degree from the University of Chicago in 1896 and the Ph.D. with chemistry as his major in 1899. From 1899 to 1907 he was an instructor in chemistry at the University of Chicago, then became Professor of Chemistry at James Millikin until 1920, the last three years of which he was also Dean and served as Acting President in 1919. In 1920 he became Assistant Director of Mellon Institute but the following year he returned to teaching as Professor of Chemistry at Knox College, serving until 1934, when he returned to James Millikin University as president, which position he held until his death.

Dr. Hessler took an active part in the scientific and educational development of the state and nation. He was a member of the American Chemical Society, and of the N.E.A., a fellow of the A.A.A.S., a member, first treasurer and a past-president of the Illinois State Academy of Science. He was a member of the Central Association of Science and Mathematics Teachers, and a member of the Illinois Association of Chemistry Teachers. He was also a member of the honor societies Phi Beta Kappa, Sigma Xi, and Phi Lambda Upsilon.

As an author of chemistry texts Dr. Hessler was well known. His first book, in collaboration with A. L. Smith, entitled *Essentials of Chemistry*, appeared in 1902. The revised edition came out in 1912. This was followed by *First Year of Science*, one of the early texts in general science, in 1915, *Junior Science* in 1919, *First Year of Chemistry* in 1931, *Workbook Manual of Chemistry* in 1932, and *Understanding Our Environment* with Shoudy in 1939. In addition he was a frequent contributor to scientific journals including SCHOOL SCIENCE AND MATHEMATICS. His last message to the students of James Millikin was written a few days before his death and appeared in *The Decaturian* August 25, 1944.

GLEN W. WARNER

ALFRED C. FIELD
1883–1944

Alfred C. Field was born in Conway, Mass., September 4, 1883. He passed away at Chicago, April 15, 1944. In Conway he attended the public school while helping to maintain the family larder. In 1912–13 he was employed by the General Electric Company at West Lynn, Massachusetts. During the next three years he attended Pratt Institute, Brooklyn and the following year became an electric engineer of the United Electric Light and Power Company.

He began his teaching career as an instructor at Pratt in 1916. Later he transferred to Case Technical High School at Detroit and later to Westwood Institute. He spent one year as vocational expert and development specialist in education in the Hawaiian Islands. Later he took special courses at the University of Illinois, Columbia, Brooklyn Polytechnic, and the University of Chicago. From the last named institution he received the Bachelor of Education degree in 1928. From 1922 until his death he was a teacher of physics at Schurz High School, Chicago. Mr. Field's associates in the department of physics subscribe to his sincerity and equipment as a successful teacher. But, best of all, the best testimony will always come from that vast student body which has to find its place in the world of tomorrow.

From an article by W. F. WILLARD

POSTWAR JOBS IN TELEVISION

Teachers, librarians, students, parents, counselors, war workers, returning veterans and others interested in postwar jobs will want to read a new six page leaflet on *Occupations in Television* by John E. Crawford of the Radio Corporation of America, just published by Occupational Index, Inc., New York University, New York 3, N. Y. Single copies are 25c, cash with order.

In brief, readable style the author discusses postwar prospects, training required, methods of entrance and advancement, range of salaries, advantages and disadvantages of television as a career. For those who want more detailed data 3 sources of further information are listed, and the 5 best books are recommended from a collection of 21 publications examined in preparing the folder.

This is one of a series of Occupational Abstracts covering the fields which are expected to expand rapidly after the war. The subscription price for the series is $2.50 a year.

SCIENCE AND MATHEMATICS IN ARMY SERVICE*

CAPTAIN DANIEL C. MCNAUGHTON
Pre-Induction Training Section, Office of the Director of Military Training, A.S.F.

In my remarks this morning I propose to spend considerable time in a discussion of the National Debt! The National Debt I am going to talk about is not one which can be measured in dollars and cents. I refer to the debt which the Nation owes to the schools of America. While we eulogize industry and labor for their astounding accomplishments in producing the supplies and weapons of war, we must not forget that the schools of the nation have played a no less important if less tangible part in enabling us to achieve victory.

Only two years ago the picture looked very different. Then, our industrial plants were straining every fiber to get needed war materials into production. Then, we were working feverishly to train soldiers, sailors, airmen. Then, German U-boats were sinking our ships within sight and sound of our shore. Then, the Allied Forces had been pushed back in North Africa nearly to the shadows of the pyramids. Then, MacArthur's long hard journey from Australia to the Philippines had just begun.

At this same time the teachers of America were asking what more they could do to help. They had done much already. They had made it possible for us to put into the field the best educated Army in this nation's history. The American soldier is generally recognized to be more mechanically minded, more alert and ingenious, and better educated than his foes. Part of this is probably due to the strange and wonderful character of our American Way of Life. One cannot grow up in an environment filled with mechanical contrivances, drive a car from the age of 16 (or less!), dodge taxis on the streets of New York or Chicago, rope steers and hunt big game in the West or weather a drought on a dry-land farm, without acquiring some unique characteristics of alertness and resourcefulness.

Much credit, however, can be given to the American schools, with their emphasis on good sport and good sportsmanship, the encouragement of curiosity, inquiry and skepticism concerning propaganda, the provision for training the whole boy on play-

* Delivered before the Annual Convention of the Central Association of Science and Mathematics Teachers at Chicago, Illinois, November 24, 1944.

ing fields, in laboratories, shops and libraries, and the substitution of student participation for the authoritarian compulsion of schools in Germany and Japan.

Of course these things have not been perfectly done in America. There are gaps here and there. We have not learned how best to develop certain qualities and understandings in our students. But on the whole American Education has come a long way.

But in 1942 teachers were saying that this was not enough. There must be some more direct way in which they could help. Instead of merely preparing boys for civilian life they wondered if there were not something different they could do to help prepare for the new demand made upon youth by their country—life in the Army. All the teachers asked was to be told what the Army needed.

You know the rest of the story. The War Department studied the training needs of the Army, and released statements of these needs through the U. S. Office of Education, so that any schools that wished to do so could, in their own ways, try to meet these needs. The response was, of course, tremendous, so much so that somewhere upward of a million boys a year receive some type of pre-induction training. During the two years since its inception pre-induction training has substantially added to the National Debt to Education.

Few fields of education offer so much that is directly useable in the armed forces as Science and Mathematics.

Science and Mathematics of a high order designed and built our battleships, our tanks, our jeeps, our Mustangs, our Super Fortresses, our radios, our antiaircraft cannon, our howitzers, even our rifles. Likewise it takes some understanding of scientific principles to operate, service, and repair these weapons.

The Army needs a few research-trained scientists to design and build and improve its equipment. For every one of these men it needs a hundred thousand who understand the basic principles of science which will enable them to use the tools of war skillfully and effectively. It is a revelation to talk to some of these soldiers and learn how deeply they understand what makes a certain device function, and how clearly they can explain how it works. I recently saw a film taken on an insignificant and remote South Pacific islet, which showed scores of improvised machines, gadgets and contraptions which the GI's had built as a substitute for items which could not be sent to them. It takes a lot of a certain kind of scientific knowledge to

improvise out of junk, spare parts, anything or nothing, a mechanism which will work, without patterns, specifications or samples, whether it be a machine to straighten the frame of a crashed airplane or a washing machine for laundering dirty socks and shirts. In fact many of these inventions have proved to be so practical that they have been copied extensively. Some of them have actually been adopted by the War Department, and put into commercial production.

The achievements of our Infantry, Artillery, Armored Force, Engineers, Signal Corps, Quartermasters, Ordnance Corps, the AAF and every other arm or service have been terrific. They are in the Big League. Their performance is not entirely the result of their Army training. It's partly because there was something extra there to begin with—a residue from all the experiences that had gone before.

Many of the boys in the science or mathematic class that you meet next Monday will go into that Big League. Have you done all you can to get them ready? Will they know the fundamental principles of mechanics, electricity, and radio that are actually used in the Army; has their science training taught them to build, to assemble, to repair; can they look at a mechanism, understand it, see what is keeping it from working? This is a very practical kind of science, and it's the kind the Army needs.

The Engineers need to know the principles of levers, pulleys, and block-and-tackle, not in abstract, but applied to the extent that they know almost instinctively where to attach the guy wires to support a camouflage net, how to anchor a ponton bridge so it will best withstand the strain.

Motor vehicle and aircraft mechanics must know the basic science of fuels, of carburetion, or combustion, of ignition, of gears, axles and frames.

We don't know just what will be the eventual assignment of the lad who goes into the Army now. We do know that the science understandings which have been referred to will be used by almost every soldier regardless of his assignment. A knowledge of the human body, disease and its transmission, water purification and safeguards to health provides an excellent foundation for the Army's training. Then too, every soldier can profit by any information you can give him about nature, the stars, weather, the tides, plants, animals, the Tropics, the Arctic. Some day these bits of information may save a man's life.

If nothing else they will enable him to while away periods of inactivity by intelligent observation of what he sees.

How is such teaching to be accomplished?

By teaching so far as possible in terms of real objects and real situations, by using equipment and apparatus which the students make themselves, by employing a wide variety of demonstration materials, teaching films, charts and other visual aids. The main thing is to start with real objects and finish with real objects, and never get too far away from real objects in between.

For example, a skillful teacher could guide his students to learn nearly all of the fundamental principles of mechanics, heat and electricity from the study of an automobile engine. Under such a procedure the students would examine the engine, dismantle it, study its parts, how they work and their relationship to each other. Then they would reassemble it and make it run. During this process students would be taught mechanical principles involved in the transmission of power through levers, cranks, belts and gears, the principles of heat transfer, latent heat, and specific heat through the study of the cooling system. Heat of combustion and the combustion itself could be learned from what goes on in the cylinder during the power stroke.

Practical electrochemistry can be studied in the storage battery, while the rest of the electrical system is a veritable laboratory for experimentation with current flow and measurement, resistance, conductivity, insulation, magnetism and electromagnetism, the electric motor and generator, the relay, heating effects, and incandescence. The fuel and exhaust system provide a fertile field for the study of flow of liquids, action of pumps, volatility, vaporization, the venturi, diffusion of gases, the gas laws and condensation. In all the parts of the engine friction could be studied, not by drawing blocks of wood across a table, but by studying friction in a setting in which it is important.

In addition to learning the principles just referred to, the student would also have learned how to work on an engine. He would have learned the use of tools. He would have gotten his hands dirty. He would have discovered whether he liked that kind of work. He would have confidence that, given more training and experience, he could repair, or at least take care of a motor vehicle if he had to.

I have given this rather extreme example, not to indicate that

all physics should be taught from a gasoline engine but to emphasize the rich store of subject matter which lies in common, everyday devices, and the great motivation which results from using such materials for instruction. I also had another purpose in mind, which is unnecessary to mention to a group of competent, experienced teachers. However, just to show you that my own orientation to the problem is sound, I shall divulge it. It is an admonition that it is not always necessary to teach science principles in textbook order, as abstract, isolated phenomena, then apply them to wheelbarrows, wagons, crowbars or well-ropes, or even worse to apparatus which has its habitat only in the science laboratory. Teachers who so desecrate (or perhaps I should say "dessicate") science usually find that "there isn't time" to devote more than a passing remark, often an oblique one at that, to the vital, important uses of the principles in automobiles, airplanes, streamlined trains, radios, television and all the other things of interest to boys of whatever age.

So far, I have confined my remarks about Army needs to science. I should like to discuss Mathematics, the "Handmaiden of Science," along similar lines. It is probably true that the more one is able to know about mathematics the better, so long as a person does not spend so much time studying a form of mathematics which he will never use that he does not have time to study something which he could use.

An analysis of Army needs in mathematics reveals that the average soldier never uses more than the common arithmetical processes. Few military men require more than arithmetic plus substitution in formulae, together with a few of the simpler geometric principles. Only a comparative handful of soldiers need what we usually refer to as the Higher Mathematics.

It seems clear, therefore, that every prospective inductee should have an opportunity to refresh his techniques in handling basic arithmetic, or to develop these skills if he is deficient in them. Every opportunity should be seized to develop accuracy and speed in computation, in order to meet the demands of Army occupations.

However, anyone who would claim that accuracy and speed are all that is necessary, would be shortsighted indeed. Of at least equal importance is the development of "Mathematical Sense." This is a rather intangible element of mathematical skill involving the ability to select the correct process to arrive at a solution of an actual problem, the ability to estimate the result

within a rather small range of error, and the ability to think clearly in quantitative terms.

The need for this "Mathematical Sense" was brought home to me on a recent occasion when I was privileged to fly 600 miles in a B-17 airplane. In making the preparations for the flight and during the flight itself, quantitative terms were never far from the consciousness of the pilot, copilot, and navigator. They thought constantly in figures. The flight plan involved fuel capacity, fuel consumption, weight distribution, departure time, elapsed time, estimated time of arrival, altitude of flight, and weather reports expressed in a numerical code.

While in the air the attention of those men was continually claimed by take-off and landing speed, indicated air speed, true air speed and ground speed in miles per hour, ground distance travelled in miles, true course and heading in compass degrees, indicated and true altitude in feet. They were concerned with fuel consumption in gallons per hour, engine speed in revolutions per minute, manifold pressure in pounds per square inch, altimeter correction in inches of mercury, cylinder-head temperature in degrees Fahrenheit, outside air temperature in Centigrade. I could go on in this vein for some time, but I believe I have given enough to prove that an airplane is no place for a person who fumbles with numbers. Other military personnel require these skills in greater or less amounts. Failure may cost many lives or even the success of a mission.

Training designed to produce this "Mathematical Sense" might well precede the drill intended to develop speed and accuracy in computation. It seems reasonable to suppose that little can be gained by drilling on mechanical processes when the quantities which are manipulated and the meanings of the processes themselves are imperfectly understood.

Such instruction might well include a large amount of laboratory work in apprehending the meaning of quantity, recognizing large numbers as multiples of known quantities, estimating numbers of people or objects, estimating distances and elevations both with and without comparison with known objects, and estimating the outcome of mathematical processes. Attention might also be given to the learning of exact and approximate equivalents of commonly used units.

Instruction along these lines could not fail to be helpful to the prospective inductee, whatever his assignment.

Earlier this morning I asked you to recall the outlook of the war two years ago in 1942. Now I suggest that we examine the present situation. In the European and South Pacific Theaters of Operations our forces are meeting with very determined resistance but are achieving gratifying success. In most other areas, our operations are satisfactory or better. Many people feel that the end of the war with Germany is in sight. There is a strong tendency to rest on our oars, recall a job well done, and turn our attention to the remote, rather than the immediate future.

Such complacency is extremely dangerous. The war is by no means over. Long, hard struggles lie before us both in Europe and in the Pacific. Winston Churchill in an address before the House of Commons recently said, "I certainly cannot predict or still less guarantee the end of the German War before the end of spring or even before we reach early summer." He also stated that it would not be prudent to assume that the war against Japan could be won in less than 18 months after Hitler's downfall.

Meanwhile induction of high school graduates continues. According to a recent statement of the National Director of Selective Service, 18-year-olds will continue to be inducted after Germany collapses, and even after the total strength of the armed forces is being reduced.

This means that the right kind of pre-induction training is as important now as it ever was, that the end of this need is not yet in sight, and that the schools must not relax their efforts in this respect until the war is won.

The items that I have called to your attention are matters that you can do something about. You can, if you will, give each of these boys the kind of training he will need in the Army, so that he will have broad foundational training in highly practical science and mathematics, learned in such a manner as to develop not only the necessary skills required in doing the actual work, but in addition to produce a type of intelligent comprehension which will result in the greatest possible understanding of what is being done.

If you as teachers of science and mathematics will accomplish this task, you will have made this National Debt to Education one which can never be retired.

THE CHEMIST IN THE PETROLEUM INDUSTRY*

GUSTAV EGLOFF
Universal Oil Products Co., Chicago, Ill.

The influence of the chemist in petroleum research and development work has been felt since 1855, when Professor Silliman of Yale University reported on the properties and commercial possibilities of Pennsylvania "rock oil." The analysis was reported four years before the famous Drake oil well came in.

Since this early period chemists and chemical engineers have played mighty roles in making the oil industry what it is today. They have contributed to the discovery of oil, its production, treatment in the oil fields, transportation, refining and marketing of products.

In the search for oil the chemist has played a leading part. He has analyzed surface and sub-surface waters, sulfur beds and salt domes associated with petroleum, and correlated the data with the geology of oil formations. He has studied gaseous emanations occurring in the neighborhood of oil deposits and developed methods for determining the presence of minute traces of hydrocarbons in the soil. These analyses have indicated that the presence of oil accumulations may be detected by telltale hydrocarbon halos at ground levels. The chemist has fixed geological relationships in underground strata by identifying characteristic mineral types and has determined permeabilities of sub-surface rock samples to enable prediction of oil flow rates.

The chemist's contributions to oil well drilling and higher ultimate production are of the first order. Special alloys have been developed possessing a hardness which gives drill bits greater resistance to the terrific wear encountered in perforating rocks to reach oil-bearing levels. Bits made of or faced with stellite, an alloy of cobalt, tungsten, and chromium or with tungsten carbide, markedly advanced the speed of drilling.

Colloidal chemistry has advanced the art of drilling by producing stable colloids so important in controlling subsurface conditions. Drilling fluids called "muds" are carefully controlled aqueous suspensions of clays, weighted with barytes, hematite, etc. Their viscosities and densities are varied as a function of

* Presented to the Chemistry Section of the Central Association of Science and Mathematics Teachers at Chicago, November 24, 1944.

well depth so as to counterbalance sub-surface pressures from gases, oil and water layers. Drilling fluids lubricate and cool the drill and carry rock cuttings to the surface. They seal off water, minor oil and gas sands and soluble materials, and prevent heaving and caving of walls.

For sealing well casings and preventing water infiltration special cements having specific times of initial and final sets are used. For wells up to 2,000 feet in depth, Portland cements are usually satisfactory, while deep wells with temperatures as high as 300°F. require cements having very special properties.

The chemist first provided nitroglycerin for disintegrating underground formations to permit a freer flow of petroleum. He later initiated the acidizing procedure for increasing the permeability of pay zones by the action of hydrochloric acid upon oil-bearing limestones and dolomites. To prevent damage to steel casings, special inhibitors were added to the acid, and by combining the acidizing procedure with rotary drilling a 25 per cent saving in costs is effected. Hydrofluoric acid is being used to react with silica in the oil strata in order to increase oil production. Acidizing of oil wells has gone into wide commercial use adding greatly to our oil supplies.

In recent technical advances, detergents to lower the surface tension of water are being injected into formations containing both oil and water to increase the flow of oil and retard the flow of water so that proportionally more oil is produced.

Once the oil has been brought to the surface, chemical demulsifiers and electrical precipitation are applied to break persistent emulsions and obviate subsequent corrosion problems by eliminating the last traces of brines.

Storage tanks and reservoirs are lined with corrosion-resistant cements or surfaced on the inside by special paints containing synthetic resins or rubbers.

In the transportation of oils to refining centers, the chemist has reduced pipeline corrosion both inside and out. The effects of dissolved oxygen on inside corrosion have been markedly reduced by the injection of sodium sulfite solutions or the addition of inhibitors such as mercaptobenzothiazole. A special pickling process for removing scale and smoothing the interior of pipelines has recently been reported to increase their capacity by fifteen per cent.

To protect the outside of pipelines against corrosion in acid soils, many methods have been employed. The pipes may be

wrapped in the factory or in the field with bitumen saturated fabrics or with aluminum foil. Special paints containing phenolic resins, rubber derivatives, or tung oils are also used as protective coatings. Cathodic protection of hundreds of miles of pipelines prevents corrosion in certain soils.

During the early part of this century the increasing number of motor cars gave the impression that there would be an impending shortage of gasoline to operate them. This brought a great amount of research to devise means of increasing the yield of motor fuel derived from each barrel of crude oil, with the result that chemists developed commercial cracking processes. The greatest factor in the conservation of petroleum resources was cracking, which not only increased the yield of gasoline to twice that obtainable by simple distillation of crude oils, but provided a product of improved combustion characteristics so that engines of higher compression ratios could be used and greater efficiencies obtained. It has been estimated by the American Petroleum Institute that in the period from 1920 to 1940, 13,584,909,000 barrels of crude oil were conserved. The percentage of gasoline from crude is still increasing because of processes being developed by chemists and chemical engineers for the more efficient utilization of all portions of petroleum.

By painstaking analytical work on the composition of cracked and straight-run gasolines and by the synthesis of pure hydrocarbons, chemists laid the foundation for present day automotive fuel developments which involve more and more the use of blends of individual hydrocarbons rather than gasolines of varying composition with uncertain combustion characteristics. Working along this line in close collaboration with engine designers, the chemist developed relationships between hydrocarbon structure and octane ratings. The refining industry now knows the type of hydrocarbons to produce in order to obtain higher engine efficiencies. Thus, processes for the manufacture of high octane rating hydrocarbons, neohexane, dixane, triptane, iso-octanes, toluene, xylenes and cumene, have been developed.

For years motor fuels were heavily treated with chemicals to produce stable water white products. This refining caused not alone loss of antiknock properties, but gasoline as well by polymerization. The chemist then developed antioxidants which stabilized the properties of gasoline and as a consequence has conserved huge volumes yearly.

The low-boiling mercaptans present in gasolines have to be removed due to their odor, hence processes for selectively removing them are in commercial operation. The mercaptans thus removed from gasolines are now utilized along with hydrogen sulfide to produce sulfuric acid, and thus an erstwhile liability has been converted into a positive asset.

The chemist and the chemical engineer improved the thermal cracking process by using catalysts which modified the reactions to increase the yield and quality of the gasoline. The by-product hydrocarbon gases are catalyzed to produce alkylates of over 92 octane rating.

The synthetic silica-alumina cracking catalyst produces higher octane base stocks and hydrocarbon gases of higher percentages of butylenes and butanes. These are processed by polymerization, alkylation, and isomerization reactions to produce more branched chain products of high octane ratings. Normal butylenes from catalytic cracking are used in part for the production of butadiene and also isobutylene for synthetic rubber.

Solid phosphoric acid catalyst polymerizes propylene and butylenes in cracked gases to polymer gasoline and iso-octanes for hydrogenation to iso-octanes. Chromium and aluminum oxide catalysts are used to dehydrogenate normal butane to butylenes for aviation gasoline and butadiene for synthetic rubber. Similar catalysts dehydrogenate ethylbenzene to styrene, the other essential component of Buna-S rubber. Ethylbenzene is being produced from the alkylation of benzene with ethylene and ethyl alcohol. Cumene, a component of 100-octane gasoline, is produced from benzene and propylene in a similar manner to ethylbenzene.

In the alkylation of iso-butane with olefins, sulfuric acid or hydrogen fluoride catalysts are employed, and iso-octane and other branched chain paraffins are produced to add octane rating to aviation fuels. Aluminum chloride catalysts are used to isomerize butane, pentane and hexanes to increase the supply of iso-paraffins.

Research has produced many compounds which are added in small amounts to gasolines, Diesel fuels and lubricating oils to improve their effectiveness and stabilize their properties. Outstanding in this group of chemicals are the phenolic and amino-phenolic inhibitors to prevent cracked gasolines from deteriorating during storage. A remarkable compound which is so

highly important in improving antiknock properties of gasoline is tetraethyl lead. Combustion accelerators, such as benzoyl peroxide and nitroparaffins, are used in the combustion of Diesel fuels. In the lubricating oil field, fatty acids are added to increase their adhesiveness to bearings. Chlorine and sulfur-containing compounds improve the effectiveness of extreme pressure lubricants. Pour-point depressors keep paraffin from crystallizing, and raise the viscosity index. Detergents are added to maintain clean bearing surfaces.

In the refining field the manufacture of special chemical derivatives is now the order of the day. Methyl, ethyl, isopropyl and butyl chlorides, ethylene dichloride and trichloroethylene, are manufactured. Ethylene from cracked gases provides ethyl alcohol and glycol, while propylene yields isopropyl alcohol and glycerol, hence nitroglycerin.

The chemist discovered solvents which are of the greatest importance: liquid sulfur dioxide, phenols, furfural or chlorex to separate aromatics from gasoline, kerosene and lubricating oils.

The chemical engineer has also come into his own in pilot plant experimentation and the design and commercial installation of renfiing processes. This type of engineering requires both research insight and practical knowledge of materials and ability to handle them. The planning of the full scale unit involves many research problems. Fractionation is only one example. We have witnessed in our generation a transition from rock-packed dephlegmators to bubble columns and to super fractionators to separate pure hydrocarbons from mixtures.

The influence of the chemical engineer in overcoming great difficulties is shown by the control of radiant energy in furnaces. In the early stages of furnace development the oil industry was frightened by the idea of using radiant heat from flames or furnace walls and only utilized convection heat. Radiant energy has been harnessed. At the present time cracking units operate with radiant energy for six months or more with no material coke deposition in the heating tubes, whereas formerly a shutdown of the plant resulted after a few hours of operation.

One further comment should be made about the place of the chemist and chemical engineer, in the petroleum industry. Formerly the highly trained technical man was allowed to dominate the laboratory and even conduct small scale experiments

in metal apparatus, but was looked upon with suspicion when he turned his hand to such practical matters as plant operation and the problems of management. This situation has changed. The advent of new processes requiring the strictest sort of technical control for their success has brought the chemist and chemical engineer to the fore in executive positions. Today it is difficult for a so-called "practical" man without technical training to direct the highly involved scientific and technical operations of the oil industry. Only the trained mind can grasp the problems presented by the many advances in petroleum technology.

The future of the oil industry will more than ever be in the hands of the scientist, the technologist, the industrialist, among whom the chemist and chemical engineer will have an important role in finding and producing petroleum, transporting and refining it into useful products, for the war effort and the peace period to come.

METROPOLITAN DETROIT SCIENCE REVIEW

This is the official quarterly journal of the Metropolitan Detroit Science Club, an organization devoted to the activities of the science groups of the Detroit area. The staff officers are members of the faculties of the science departments of the high schools and colleges of the Detroit community. The December issue contains articles by C. Louis Thiele, A. Lynn Zwickey, Marjorie T. Bingham, Frances W. Lamb, and others. A copy of this issue may be obtained by writing the editor, Louis Panush, Central High School, 2425 Tuxedo Ave., Detroit 6, Michigan.

CORDLESS ELECTRIC FLATIRON

Cordless electric flatirons, soon to be in production, draw heating electric current from the house circuit only when the iron is resting on an automatic safety base placed nearby. Two prongs extending from the back of the iron then make electric contact which permits the current to flow through heating elements in the iron. The current ceases to flow when the iron is removed.

The safety base, connected to an electric outlet, contains a thermostat, an adjustable regulator which controls the flow of electricity to the iron, and the temperature desired. This prevents overheating, and also eliminates all danger of fire as no current flows after the iron has reached the temperature for which the regulator is set.

This new safety household ironing device was developed here in the laboratory of the Eureka Vacuum Cleaner Company, and the company now has authorization from the War Production Board to manufacture a limited number.

"THOSE DRUGS OF OURS"*

FREDERICK F. YONKMAN
Ciba Pharmaceutical Products Co., Inc.,
Lafayette Park, Summit, N. J.

Not too many years ago in a Boston Hospital a youngster of seven years lay dying with an acute attack of asthma, gasping desperately for breath. She no longer responded to the beneficent action of adrenalin which is the drug ordinarily employed by physicians in such situations. So the alert, attending physician tried a new form of treatment of which he had only recently learned and one still in the experimental stage of development. This treatment consisted of injecting by vein a drug known as aminophylline which is rather closely related to a common constituent in tea. The result of the treatment was immediate and dramatic: respiration improved, color returned to normal, anxiety and apprehension were dispelled and a life was saved. Since this episode, the same experience has been duplicated very frequently with equally gratifying results.

Equally satisfactory results as those cited can be reported for many of our valuable drugs. These medicinal agents have come to their present state of importance, as a rule, only after long, careful, painstaking research in the numerous excellent laboratories and clinics, not only in this country, but across the seas. How they come about is frequently of as much interest as their actual achievements in the hands of the physician or nurse.

One of our very important drugs is digitalis employed in certain types of heart disease. In Shropshire, England, back about 1775 old Dr. Withering, a physician of some repute, had learned of an elderly woman who was purported to have in her possession the formula for preparing a decoction from one of her common garden flowers, the purple foxglove, which she had administered to several of the town folk afflicted with dropsy, apparently with good results. Dr. Withering's curiosity was aroused naturally, since he was frequently called upon to treat the same condition and not always with satisfactory results. To his undying credit, Dr. Withering, the physician, stooped to pay the woman a visit, inquired as to her foxglove potion, dared to try it on some of his patients and, much to his surprise, obtained excellent results. Dr. Withering was a careful observer and many

* An address before the Annual Convention of the Central Association of Science and Mathematics Teachers November 24, 1944, at the Stevens Hotel in Chicago.

of his original observations as to effects produced by foxglove or digitalis serve today as criteria for the modern physician to gauge dosage and potency of the preparation employed.

Because of the variability in potency of different sources of digitalis, the drug must be carefully standardized before administration to the patient. For this purpose various animals are employed; ordinarily the frog and the cat are chosen, particularly the latter because of the uniform results it usually affords. Purification of digitalis preparations has progressed over the years so that now all preparations offered to the physician have uniform potency, assuring the best for the patient. Not only are preparations available in solution or tablet form for oral ingestion but highly purified products are available which can be given by vein in case of emergency.

Digitalis thus represents a type of drug which nature affords in a common plant and which still persists as the best drug of its type for the treatment of certain heart diseases. Nature offers other drugs such as quinine for malaria, cocaine for local anesthesia, ephedrine for elevating blood pressure, morphine for numbing pain, penicillin for killing bacteria, and many others. All have their merits but scientists are constantly on the alert in their endeavor to obtain better medicaments than those provided by nature. In many instances they have succeeded and the development of their successes makes an interesting story for the inquisitive, appreciative beneficiary of their efforts.

The sulfa drugs are good illustrations of a rational approach which the scientist employs in his attempt to improve upon nature. Domagk, the German scientist, believed that since certain dyes possesses mild lethal action on certain bacteria, prontosil, a staining dye liberating sulfanilamide, might possess similar properties. His attempts to treat infection in rats and guinea pigs were successful and we soon learned how to use the drug in combating severe infections in man. Sulfanilamide was quickly followed by sulfapyridine, sulfathiazole, sulfadiazine and others, each with its own advantages, illustrating the importance of chemical structure in relation of drugs to disease.

But the sulfa drugs were not without their hazards and further search resulted in the development of penicillin whose bacteria-killing powers were first recognized by Dr. Fleming in England in 1929. These were given renewed attention by Dr. Florey and his coworkers in Britain and after the miraculously short period of approximately three or four years, the Allied

Armed forces had enough penicillin to care for average needs, thanks to the energy and devotion of our modern scientists and the enterprise of the American business man. And it was only shortly thereafter that sufficient penicillin became available in all of our hospitals and those in England and Canada to care for average civilian needs. From the lowly mold, *penicillium notatum*, to the highly purified penicillin is a wide gap, bridged by modern science with miraculous performances. But more miraculous still, it seems, is the fact that penicillin is practically non-toxic. It is perhaps the best illustration of a highly potent drug possessing relatively little, if any toxicity. As a rule toxicity parallels potency of a drug. What do penicillin's achievements portend? A new threshold into a far more magnificent era of improved health for modern man? Imagination here may be expansive but perhaps it would be justified; future events are eagerly awaited.

One of man's greatest miseries is pain. It is the chief reason for keeping the physician in shoes and daily food. Either mild or severe, it urges the afflicted to seek relief. Fortunately aspirin is an excellent drug for many average pains but a patient so afflicted, especially if the pain be constant, owes himself better treatment than self-medication in order that any latent, serious organic ailment may be nipped in the bud rather than be permitted, under easement of pain, to progress to serious malfunction of an organ by either inflammation or cancer.

Many pains can not be controlled satisfactorily by aspirin. Among other agents one finds antipyrine, amidopyrine, codeine, morphine or, as the case might demand, cocaine. All have their advantages and disadvantages. Morphine is most potent and positive of action but if used for prolonged periods of time, as in inoperable cancer, it may be annoyingly constipating and may eventually lead to addiction for habit formation. Hence, science has not been asleep; her devotees have been constant in their pursuit of an adequate substitute for morphine. A good substitute, but not entirely adequate, is now available in the form of demerol (the ethyl ester of 1-methyl, 4-phenyl, piperidine, 4-carboxylic acid). It is not as potent as morphine in relieving pain but it is better than codeine; it is less addicting and can be made synthetically. The latter feature was of tremendous importance two years ago when, according to the best estimates, we had in the United States only about one or one and one-half year's supply of morphine left for all medical purposes, army

and civilian, and probability of obtaining more rather remote since the sources of supply were pretty much in the control of the Japs not long after Pearl Harbor. Yes, our scientists have demonstrated here too that emergencies can be met in more ways than once; the loss of some advantage, such as potency, may be balanced by another, such as capability of synthesis, or production within the confines of a laboratory far removed from the natufal sources of supply.

The same might be said for our scientists in the case of quinine used in the treatment of malaria. With our main natural sources under Japanese control in the Dutch East Indies, our chemists made available to us atabrine and plasmochin which, when properly employed, prove to be pretty fair substitutes for quinine. These, too, are synthetized in the laboratory. More recently quinine itself was synthetized by a new process developed by two young chemists. As yet this remarkable achievement is not commercially feasible but hope is permissible when our chemists perform as they have.

Another ailment afflicting mankind is restlessness and inability to relax or to sleep. Man has long resorted to various forms of treatment for such disturbances, especially for insomnia. They range from soft music, blue lights, hot baths, counting sheep, changing positions, and cursing one's fate, to imbibing of a night cap, or a few moments with Tennyson, Shakespeare, Browning or the Scriptures, and hosts of other pet and favored remedies. But the physician who appreciates the importance of physiologic rest for both the well and ill utilizes the relaxing capacities of various drugs. Among several, we now find one of the most satisfactory types, the barbiturates. There are several, some of which act slowly and others rapidly. Some are even employed to anesthetize the patient for a surgical operation. There are some so potent, yet in proper hands safe, that as the patient counts, 1, 2, 3, etc., at the rate of one count per second, he may be sound asleep after thickly enumerating or mumbling 18 or 26; the shortness of the count will depend upon the speed of injection into the vein and the speed of the patient's reaction to the drugs. Here again, the chemist has so modified the original mother substance, barbituric acid, as to make it shorter acting or more intensive in its action.

Tons of barbiturates are used annually in the United States. Their use and desirable action afford real problems, however; not infrequently overdosage results from either intentional or ac-

cidental use. Unless counteracted, the drug will cause the patient to die in his sleep. Among drugs employed for such counteraction and improvement of the patient are caffeine, strychnine, metrazol, picrotoxin, coramine, oxygen, sodium succinate, blood plasma, solutions of glucose and sodium chloride. Constant observation of the patient is mandatory until consciousness is regained. Not long ago one of my former students revived a patient after 48 hours of constant vigil and proper treatment; this experience was especially gratifying because the patient had ingested eight grams of a barbiturate whose average therapeutic dose was only about one tenth of a gram. In other words, she survived a dose some eighty times larger than normally required for therapeutic effects such as inducing mild sedation. Here again the scientist has offered us appropriate antagonists to the action of barbiturates.

Another approach to the problem regarding importance of various drugs would be to review their action within each system comprising man, namely, the skeletal system or bone structure, the muscular system, digestive and respiratory systems and so on but time does not permit. Allow me to call attention, however, to that system which is in constant touch with all other systems, namely, that of circulation of blood. Blood must be important for many reasons because we have so much of it. It represents approximately ten per cent of our body weight or about six quarts for an average man. Too much or too little results in disease; the same holds true for the several components of blood, even though total fluid bulk may be normal. Blood is mediated throughout the body through closed vessels called arteries, veins and capillaries which are under the influence of involuntary nerves and certain chemicals. Thus, blood vessels may either relax to cause a drop in pressure or constrict to effect a rise in pressure.

Whole blood, or its dried components, can be used to promote healing of ulcers; here it is applied directly to the ulcerous area. Blood proteins can be injected into patients in shock, such as the seriously injured soldier or sailor who has lost considerable quantities of blood. Whole blood is of advantage in this situation also but plasma proteins are most essential for maintaining blood pressure. Certain blood plasma proteins are now being used to immunize against measles; this is a most recent discovery and strangely enough, to some perhaps, was made in a laboratory of physical chemistry. Blood clotting can be promoted by certain

plasma proteins and calcium or prevented from clotting either by use of heparin, which can be obtained from the liver, or by dicoumarol, originally extracted from spoiled sweet clover. These are but a few items of interest in relation to our topic—blood can be a drug and drugs in turn can affect blood functions favorably or unfavorably.

Amongst numerous other recently introduced drugs of interest one finds thiouracil for treatment of toxic goitre or hyperthyroidism, either in place of or in conjunction with iodine, zephiran and phemerol as nonmercurial, non-phenolic antiseptics of high potency, sex hormones such as estrogens and androgens to tide over respectively the female and male through their climacteric periods, and more recently the anti-tuberculous agents to which considerable attention has recently been given. Because of the importance of this disease, adequate discussion of developments in this field seems warranted. This discussion is taken from an article by your present writer for *Modern Hospital*, Volume 63, page 96, 1944 (October).

"Tuberculosis is one of the oldest diseases afflicting mankind and ranks in severity with some of our most incapacitating and lethal diseases which include among others cardio-renal disease, cancer and diabetes.

"Many forms of treatment have been recommended for the arrest of tuberculosis, especially that of the pulmonary type. These include absolute bed rest, a well-balanced diet of high caloric value and numerous forms of long since discarded medications which numbered among them such relics as creosote and guaiacol in some form or another. Some physicians even recommended nonstrenuous employment in tar-roofing gangs so that adequate inhalation of 'tar fumes' might be assured.

"More recently, surgical procedures were introduced with the intent of placing at almost complete rest the affected portions of the lung involved. These procedures included any reasonable technic by which the diaphragm might be immobilized or splinted. At first the phrenic nerve was injected with alcohol or procaine, or it was transected or crushed so as to interfere with neural transmission of nerve impulses controlling the diaphragm. This procedure was accompanied, as a rule, by partial or complete collapse of the affected lung which was produced by insertion of known volumes of sterile air commensurate with the degree of collapse desired, as determined by the fluoroscopic or x-ray technic.

"Since phrenic nerve damage and lung collapse were frequently insufficient to assure the desired effect, more extensive surgery was resorted to in the form of releasing pleural adhesions through rib resected portals in the chest wall. Such adhesions usually were responsible for failure of lung collapse even though the associated diaphragmatic leaf had been satisfactorily splinted by divorcing it of its neural control through phrenic nerve sectioning and despite the fact that air had been inserted into the thorax.

"Somewhat later, air was introduced under pressure into the peritoneal cavity in order to force the diaphragm higher up into the thoracic cage. This procedure proved to be an efficacious adjunct to existing forms of therapy but it, too, was not without its hazards. Recently, Rilance and Warring of Connecticut have recommended on the basis of their study of 101 patients so treated that the routine use of pneumoperitoneum would not seem to be desirable because the incidence of acute appendicitis in these patients thus treated was 11 times greater than in other sanatorium patients. The cause of such a complication has not been determined but its incidence in this series connotes genuine caution in selection of the use of pneumoperitoneum as a subsidiary form of therapy in this disease.

"With the successful advent of sulfa drug therapy in many of our common infections it was only reasonable to anticipate the trial of several such commonly employed sulfa derivatives in tuberculosis. *In vitro* studies were soon followed by attempts to arrest or cure experimental tuberculosis in guinea pigs and clinical tuberculosis in man. The latter attempts were fraught with the most disheartening results.

"However, the sulfone radicle has been more recently modified into several forms, each of which, when promising *in vitro*, was tested in the tuberculous guinea pig and man. Among these latter agents one encounters promine (P, P′-diaminodiphenylsulfone-N, N′-didextrose sulfonate) and diasone (disodium formaldehyde sulfoxylate diaminodiphenylsulfone). Both of these synthetic compounds were primarily employed in experimental tuberculosis in guinea pigs and the results of these investigations were sufficiently promising to warrant their employment in the treatment of tuberculosis in man.

"Promin was studied chiefly by Hinshaw, Pfuetze and Feldman, and diasone by Petter and Prenzlau. The results of both studies are indeed promising but the limitations of this type of

compound, as well as the hopes entertained for it, are well gained from the published results of the latter authors' studies (*Amer. Rev. Tuberculosis* 49: 308, 1944, April).

"Pertinent points cited by them include:

"1. The drug should be administered orally with meals in a total daily dose of one gram for a period of at least 120 days unless serious toxic symptoms interfere.

"2. Such treatment has resulted in striking results in some cases.

"3. Greatest improvement occurred in the first two or three months of therapy but improvement continued thence, even though less markedly.

"4. Chemotherapy replaced, in some instances, enforced bed rest and various forms of collapse measures, with no regrets on the part of the authors.

"5. Bronchogenic dissemination has not occurred during this type and period of chemotherapy.

"6. At least two patients of the series owe their lives to the chemical and six others were sufficiently improved to permit thoracoplasty.

"7. Tuberculosis located elsewhere than in the lungs responded very favorably.

"8. Two diabetic patients in this series tolerated the drug well.

"9. Enthusiasm regarding the drug must be held in reasonable bounds because of the unpredictable nature of tuberculosis. Changes may be due to other than drug effects. The chemical is still experimental and should be under the strict control of competent physicians who have ready access to adequate laboratory facilities.

"Diasone seems, perhaps, to be somewhat better tolerated than promin but it, too, has its disadvantages since it may produce tolerance, lethargy, dermatitis, primary exacerbation of cough and expectoration with secondary improvement of these, nausea and vomiting, nervousness, headache, diplopia and slight tremor. At no time were there any evidences of urinary disturbance but after careful observations of the blood 'no serious or uncontrollable reactions have occurred' to date.

"The authors conclude by stating: 'The administration of diasone in adequate doses has been accompanied by favorable clinical progress in the majority of patients studied by us without harm to the host. It, therefore, may be considered as an ad-

junct therapeutic agent and another indicator that the chapter of chemotherapy of tuberculosis, considered by many as closed, is really open to those who will continue to inquire, observe and evaluate.'

"In concluding their report involving the study of promin's effect in 36 cases, Hinshaw, Pfuetze and Feldman state: ' . . . Progress is continuing at a satisfactory rate toward development of a clinically practicable chemotherapeutic agent for use in selected cases of tuberculosis. We believe that a great deal of work remains before attainment of this goal.'

"In this direction, Feldman, Hinshaw and Mann (*Proc. Staff Meet. Mayo Clinic* 19: 25, 1944, Jan.) report favorably on a new, less toxic sulfone derivative, 4, 2′-diaminophenyl-5′-thiazolesulfone, known as promizole. This drug seems to offer real promise as a chemotherapeutic agent in the treatment of tuberculosis but, again, the esteemed members of the committee on therapy of the American Trudeau Society, of which Hinshaw is chairman, rightfully caution against blind optimism: ' . . . Promin, diasone, promizole and certain related compounds appear to possess in varying degree the striking ability to restrain the development of experimental tuberculosis in guinea pigs. It is recognized that experimentally induced tuberculosis in guinea pigs offers many contrasts with clinical tuberculosis in human beings, even though the causative organism is the same.

"'It is the opinion of the committee that the clinical and roentgenological data so far made available to the committee on the action of diasone in human tuberculosis are as yet inadequate both quantitatively and qualitatively to permit, even tentatively, a positive evaluation of its curvative effects upon tuberculosis in human beings. . . .

"'Until controlled studies of adequate scope have been reported it is recommended that none of these drugs be used for treating tuberculous patients except under conditions which will appreciably add to our knowledge of their clinical action, and in the presence of adequate facilities to protect patients effectively from their potentially serious toxic effects. . . .

"'Any use of chemotherapeutic agents, including diasone, in the treatment of tuberculous patients must, therefore, be regarded as purely a project in clinical investigation. It must be again emphasized that such use is not without hazard and that the roentgenological and clinical evidence reviewed by the committee gives no justification at this time for any attitude con-

cerning the value of these drugs in patients other than one of critical interest.'

"Hence, enthusiasm rises and wanes but steady progress ensues. The sulfones are indicative but not without hazard in the treatment of the tuberculous patient; synthetic specifics are frequently such two-edged swords. What does nature still hide from us—is it some as yet unknown, active, but nontoxic, naturally occurring specific? Time may yet reveal such a secret. The ultimate goal well justifies stupendous and relentless search for such a medicament."

Only by thorough and sympathetic understanding and loyal cooperation can our scientists continue to improve upon "those drugs of ours" for the benefit of mankind. As scientists, we are confident that your part in this teamplay will be well-executed, whether it be in the laboratory or in the classroom. As important as it might be to participate in the actual laboratory problem involving a test or a synthesis, it is just as important, and perhaps more so to inspire others to such accomplishment. That *may* be your mission and it *is* your privilege and satisfaction.

SCHOOL WAR SAVINGS

In the three years since Pearl Harbor over one billion dollars in War Bond and Stamp purchases have been credited to the boys and girls in U. S. schools. Monthly savings average more than $50 million, enough to pay for 200 heavy bombers for the fighting fronts now, and to finance a month at college for more than 833,000 of these same youngsters ten years from now when their Bonds mature. In short, a $100 Bond now may pay for a month at college in 1955.

Since January, 1944, schools have completed campaigns to finance 2,820 planes ranging in price from $3,000 for a liaison plane to $600,000 for a B-29. Last year's campaigns financed 33,100 jeeps at $1,165; 11,600 amphibian jeeps at $2,090; 11,400 flying jeeps at $3,000; 7,690 parachutes; 6,170 life floats; 5,160 motor scooters; 1,490 field ambulances; plus gliders, walkie-talkies, tanks, potato peeling machines and many other items.

Begun in 1941 the school War Savings Program reaches every state, Alaska, Puerto Rico, and the Hawaiian Islands. In this area there are about 30,000,000 students, 1,000,000 teachers, and 225,000 schools, nearly half of which are one-room schools.

To teach American students, and through them to teach their families and neighbors, both how to save and why it is important to save during this war crisis. Thus the first objective of the Schools-at-War Program is education for thrift; and the second its application—saving through the purchase of War Bonds and Stamps.

During the first semester of 1944–45, every school has been asked to try to qualify for the Schools-at-War flag and to finance some piece of army or navy equipment.

MATHEMATICS AND SCIENCE IN A LIBERAL EDUCATION*

MARK H. INGRAHAM
Dean, College of Letters and Science,
University of Wisconsin

Ladies and gentlemen, as I understand it, when the Romans used the phrase "Liberal Arts," *Artes Liberales*, they referred to those branches of learning which only free men were permitted to pursue. Although I do not, myself, believe in always strictly following the original meaning of the word or phrase, today I want to explore the contribution that the study of mathematics and science can make to the life of a freeman, and to say something about how this contribution can be enhanced.

I wish to discuss this subject in relation to three aspects of the education of a free man. First, we should seek the enrichment of the life of the student and I do not believe it is selfish on his part to seek this enrichment. It is his birthright, left to him by generations of scholars. Second, the early education of a free man should leave freedom for later specialization and later choices of occupation. Third, the education of a free man should equip him for his duty as a citizen of the state.

When I say that the education of a free man should enrich his own life, I mean this in a very broad sense, spreading all the way from the mere relief of boredom to the deepest intellectual and esthetic satisfactions. Even the relief from boredom is no mean accomplishment. Americans pay billions of dollars a year for this and, until rationing, untold quantities of gasoline. But, of course, the enrichment of life goes far beyond any escape mechanism. To lead a rich life a man must be the kind who will draw out the best in the companionship of others. No man is the same to two different persons, and another person may give little to me where he has much to give to another, not because of the fault of the giver, but of the receiver. Enrichment of life includes a sense of the unity of one's life with that of the race and with one's enrivonment. Enrichment of life includes a satisfaction at the level of the appreciation of poetry, or art, and of the understanding of knowledge. It also includes just plain fun.

A man is not a free man if his past has tied his future to such

* Presented before the Junior College Group of the Central Association of Science and Mathematics Teachers at Chicago, November 25, 1944.

an extent that he is constantly not making choices of volition but by the compulsion of inadequacy. It is the minority of cases, and I believe the unfortunate ones, where a boy in high school really knows what he wants to be when he is a man. I had the good fortune of not deciding on my profession, although I thought I had, until I was through college and through two years in the service. One of the ablest scientists I know, a member of the National Academy, majored in the classics and lives without regret that he did so. One's freedom should be maintained as long as possible. One of the greatest accomplishments that I know is to come up to the emeritus status with the flexibility to still make a decision as to what one should do. How would this do for a definition of liberal education? A man is liberally educated if when he becomes emeritus he genuinely has a large freedom of choice of occupation. I think with pleasure of three scientists, one of whom spent his years after retirement in the intensive study of Japanese prints; the second in writing delightful essays of noble inspiration on the lives of great scientists; and the third who had had his scientific career interrupted by about forty years of college administration has made an international reputation in biology since reaching seventy-five.

But no freedom is complete. One man's activity limits his neighbor and the free man must also share in the government that determines the controls of his and his fellows' freedom. The education for freedom must include an education for this participation. Freedom without such education is dangerous, and I am not sure but that the Romans were right in also considering as dangerous such education without freedom.

I turn now to consider the contributions that science and mathematics make or can make in the education of a free man, especially with respect to the three forms of freedom I have mentioned. Because I put certain objectives first and the means last, do not think that I have fallen into the currently fashionable error of believing that is how we build sane educational practice. Some day it may be possible to do this, but as yet we know far better what portion of our education is good than why it is. The real logic of this paper is that 1) experience, subjective and objective, has amply demonstrated the liberalizing value of mathematics and science and some inadequacies in its teaching; 2) the knowledge derived from this experience may be organized in many ways, some of them illuminating. The present

description is derived from what to the author is such an illuminating organization. But before that attempt to fit these contributions into a pattern, I would like to say a few words as to what those contributions themselves are.

First of all, the study of science and mathematics introduces us to a large body of organized and valuable information. I think we too often, in saying what scientific education can do in the way of introducing us to methods of thinking, forget the value of an informed mind. It seems to me that we should mark as fatuous any scientific education that isn't very largely informative. Secondly, a study of science and mathematics introduces us to great examples of constructive imagination. Of course, not the only examples. On one occasion, I risked my reputation by listing as, in my opinion, the greatest book ever written by a single individual, Dante's *Divine Comedy*, and further risked it by placing Newton's *Principia* second. In the company I then was, the second statement was the greater risk. I presume that is not the case now. It is not just the facts, but the organization of the facts that marks science. The arrangement of the Periodic Table, the Mendelian Hypothesis, the tracing of the history of the glacial epoch, and the quadratic reciprocity theory are not examples of mere noting of facts, but of a type of imagination that can conceive those facts in their relationships. Thirdly, though trite, we must not forget that the study of science should give insight into the scientific method including such aspects as the method of forming deductive patterns, most clearly exemplified in mathematics, the method of forming hypothetical patterns to be exploited deductively and checked inductively, the method of the laboratory which both checks these hypothetical patterns and leads one to form new patterns, and throughout the attaining of certain standards of excellence, as for example the standards of mathematical rigor and mathematical elegance, and the standards of scientific verification. We should also recognize that both mathematics and the mathematical sciences develop the ideas of quantitative thinking to a marked degree.

With this introduction I would like to point out how the study of mathematics and science can serve the education of the free man as detailed above, with some comments as to how this service can be maximized.

First of all, I think the study of mathematics and science is for a great many students fun, and can be made so for many

others. The last time I looked up the figures there were a higher percentage of F's and a higher percentage of A's in mathematics than in any other subject of large election in the University of Wisconsin. Correlative to that, I believe there are more students who hate mathematics and more students who love it than any other subject. I just cannot understand how a person would not enjoy Euclid's proof that there are an infinite number of primes or the fact that every integer can be expressed as the sum of four squares. Incidentally, in my opinion there is more fun in number theory than in most branches of mathematics, and there are parts of number theory, for instance the sieve of Eratosthenes, which may be shown to the students far before algebra is usually introduced. Other people find a great deal of pleasure in the coordination of brain and hand, which is developed in the demonstration of natural phenomena by technical laboratory means, and it would be pretty difficult to be bored in the country side if one knew a little of botany and ecology.

The man who has a knowledge of natural phenomena is far less lonely than he who has not. It not only opens for him the companionship of many of the best minds around him, but also the sense that he is a part of an orderly yet wonderfully diverse universe. In the teaching of science in particular it seems to me to be well to stress this wholeness and this diversity even at the expense, at times, of time spent on acquiring technical knowledge.

May I say quite frankly that I do not think a man who has narrowly specialized in mathematics or who has narrowly specialized in one of the sciences has gained, thereby, enough to make up for what he has lost. The man who has shut out from himself a continuing interest in literature and in history is blind to a whole band in our intellectual spectrum. I am, therefore, not pleading for the life of a scientist to the exclusion of all else but for the enrichment which science can bring to a life which is also to be enriched by the study of the humanities. I think, therefore, one should consciously consider in teaching either mathematics or science that broad relationships of man and his environment should be revealed to the student and the plain pleasure that even a non-scientific student can get from the study, as well as any technical efficiency that may be attained.

In planning a curriculum, I believe one of the prime considerations is to keep, as long as possible, as many doors open for

the student's future as can be. Mathematics is a good illustration. To a mathematician, mathematics is a joy in itself, but for everyone it can be a useful tool. The degree of usefulness depends upon the extent of the knowledge, but to even a greater degree upon the mastery of the portion of the subject covered. At the University of Wisconsin a student may enter the university without any high school mathematics. However, unless he has had a year of geometry and a year and a half of algebra, he may not have full admission to the College of Engineering nor the course in Agricultural Engineering, and unless he has had a year of geometry and a year of algebra, or unless he has made these up (which is seldom done) he may take no work in astronomy, mathematics or physics, he may not enter the course in Chemistry, Medical Technology, Nursing or Pharmacy, and he may not major or specialize in American Institutions, Bacteriology, Biology, Chemistry, Commerce, Economics, Geology, Humanities, International Relations, Mathematics, Physics, Pre-Medicine, Political Science, Psychology, Sociology or Zoology. He may not become a junior in the College of Agriculture. These decisions were not made upon the urgings of the Department of Mathematics, but upon the advice of the individual departments concerned as to whether or not the student was qualified to do the work unless he has had this small amount of mathematical preparation. These are too many doors for a boy of fifteen or sixteen to slam in his own face.

No one of the sciences could probably furnish a similar list, and yet whole areas of understanding are closed if at the proper time a student does not become acquainted with the basic scientific facts in several fields, and with the scientific method. To keep ones choices open as to both vocations and avocations, it is clear that a person should have a fundamental knowledge of history, science, and the social studies, an appreciation of literature, ability to read and write accurately (the study of science is one of the media for attaining this ability and should be consciously used), the ability to think quantitatively and at least to be accurate in elementary calculations. I would grant immediately that a person may not meet all these requirements and may still have a rich life, and by no means be a failure. I am asserting that such a person is not as free as he should be.

When we deal with the duties of the citizen, it must be granted that the first subjects we must insist upon would be history and the analytical social studies. However, the problems with

which a community must deal and deal intelligently require not only the advice of the expert scientist, but I believe also the judgment of a citizenry, not too ignorant of the basic ideas of science and technology. One of the men I know who has the broadest conception of the proper controls of radio is an electrical engineer. The decisions as to the issuance of bonds for a new sewer system certainly involve problems of bacteriology, and the person who gets scared every time he sees a statistical table is, in my opinion, unqualified to vote.

I wish to end with a few more or less dogmatic statements concerning the teaching of science and of mathematics which I believe are the corollaries of the foregoing development. The more dogmatic statements will be concerning mathematics, the less, concerning the teaching of science. First, throughout the mathematical training should be placed more emphasis on the mastery of arithmetic including the ability to carry out long arithmetic processes accurately with suitable checks. This facility with arithmetic gives the insight that makes algebra easy, opens up many applications to the individual, makes it easier for him to catch the buncombe of a grocery clerk or a politician, and next, perhaps, to concise and grammatical speech and understanding reading is the most used of our intellectual tools. Secondly, I would make mathematics more amusing by including some topics just because of the fun involved. Illustrations are items connected with prime numbers, and I would say a reintroduction of continued fractions. Thirdly, I would place more emphasis on proofs than is currently the fashion. Please do not misunderstand me in this regard. I think there is little value in memorizing a proof in the step by step detail fashion that some students resort to, and I do not know that we need to cover more proofs than at present. I do feel that greater emphasis on the nature of proof and the understanding of proofs is needed. We do not ask students to go through proofs chiefly to convince themselves that a statement is true. Generations of scrutiny of Euclid will be a better guarantee of the validity of the reasoning than the student's own examination. But proofs of theorems indicate the interrelationship between one portion of a theory and its general background. It is only through the proofs that the structural pattern is seen. It is only through the proofs that the constructive imagination of a mathematician is understood. It is chiefly through the proofs that the beauty of mathematics is revealed to the student. I

would suggest that frequently, in place of proving five theorems, it would be wise to get five proofs of the same theorem. Take a theorem like that of Pythagoras. I have used that theorem constantly and have known how to prove that theorem occasionally for the last three decades but it was not until recently when I noted a proof new to me, that I understood certain aspects of its relationship to other parts of mathematics that I had never seen before, and that the theorem became a "natural" instead of a sport.

Where you may ask will the time come for more drill in arithmetic, for more fun in subject matter, and for more attention to proof. My answer is a clear cut compromise. You will have to get some of the time by omitting topics and you will have to get a great deal of the time by demanding more of the student than is usually done, and in some cases you will have a chance to do what I indicate only for the better students who can brush off the ordinary amount of mathematics in a trivial amount of time. I may add, however, that I am so firmly convinced that much of the time and energy that a student puts on mathematics could be saved if the arithmetic were more soundly founded, that I believe that aspect will be time saving rather than time using.

I am very much more tentative in my conclusions as to the teaching of science. My first conclusion, however, is the negative one that it is unwise to give up laboratory work in science to teaching exclusively by lecture and by demonstration. However, I believe that for a very large number of students, both those who are not going to be scientists and those whose scientific endeavor is going to be in a different field, the laboratory work could be modified so as to emphasize to a lesser degree modern technology and to a greater degree scientific imagination. Certainly a student should have the opportunity to have a question posed and find out for himself the answer by planning and carrying out the experiment with, if necessary, quite crude laboratory techniques. In large institutions and perhaps even in large high schools, there should be the choice for the introductory courses between one that is especially planned to prepare the student for the more advanced phases of the same subject, and those that are the background of the culture intelligent citizen. I do not like survey courses which merely attempt to cover a larger area by making the coating thinner. I do believe, however, that for the student who is only going to devote a strictly limited

time to the physical sciences, a more satisfying selection of topics and of laboratory experiments can be chosen from the fields of physics and chemistry than from either one alone. I do believe that for the student who is not going to be a biologist, a more useful selection of topics can be chosen from the fields of zoology, botany, human physiology, and bacteriology, than from zoology or botany alone, and that the general citizen who does not complement his geography with geology or vice versa, has paid highly for his dab of specialization by only dipping into one of these subjects. Courses which spread much beyond the ranges just indicated lack so much in unity that I doubt the wisdom of giving them.

These interdepartmental programs lead to some difficult educational problems; problems of advising, problems of the student who changes his mind (a privilege I wish to maintain), problems of selection of laboratory material that will not be too spotty, and at the same time problems of maintaining standards which have been established for the technical introductory courses, and have not been a tradition of the survey courses. Some of these things I have said tentatively even if they sounded dogmatic. May I be dogmatic on this, that unless these broader courses are planned by able scientists rather than as the escape activity of a man who has not done any research, the breath of life will not be in them. And for both mathematics and science I would like to make one further remark. The subjects should be taught in such a way that social and economic significance of modern technology and modern scientific knowledge is brought to the attention of the future citizen. Moreover, both of these subjects should be taught with much greater emphasis on their history, on their development as human activities, and on their place along with literature and art as the flowering of the human spirit, than has been done in the past. The fundamental theorem of algebra, without a knowledge of Gauss, Newton's interpolation theory with no idea of who Newton was, the Mendelian law with no picture of the priest, Mendel, and his garden, does not represent the knowledge of science as a living organism that we should have.

A farm is a packaging establishment where energy from the sun is bottled up in the molecules of matter and stored for future use.

Atoms in Action—George Russell Harrison

AIRCRAFT INSTRUMENTATION*

W. W. DAVIES
Research Engineer, United Air Lines, Inc., Chicago, Illinois

Instrumentation is one of the most important features of aircraft design, and the type and use of instrumentation is of highest importance to any airline, or operator. By means of instruments the airplane is guided in its flight, and is dependent upon them for its ability to produce safe, on time, comfortable operation.

This paper will not attempt to go into the highly technical developments of any particular instrument as there are many ramifications to any individual development, which could well be a paper within itself. Therefore, the treatment here will be of a rather general nature, and description of instruments will be made for only a few of the fundamental ones. For the purpose of presentation the subject to be considered will be as follows:

A. Fundamental characteristics of some aircraft instruments

B. Present instrumentation in commercial aircraft

C. Some new possibilities in instrumentation

For the purpose of simplification, instruments will be classified under three main categories, namely,

1. Flight instruments, or those instruments which are used for the proper navigation or handling of the airplane in flight conditions.

2. Power plant, or engine instruments are the instruments that give a complete interpretation of the operation of the engine.

3. Accessory instruments. These are instruments used to define, or interpret the operation of accessories or general characteristics of aircraft operation, not properly classed under the first two categories described above.

A. FUNDAMENTAL CHARACTERISTICS OF SOME AIRCRAFT INSTRUMENTS

1. Flight or Navigation Instrumentation

a. Types of Instruments

Generally speaking the majority of instruments used in aircraft are pressure sensitive, or pressure actuated. Of this, there

* Presented before the Physics Section of the Central Association of Science and Mathematics Teachers, November 24, 1944.

are two basic types in general use. The first is a diaphragm type in which a metal diaphragm expands or contracts with changes in pressure. Usually, the diaphragm itself, commonly called "aneroid," is a whole disc formed from thin metal sheet. A measure of the sensitivity or movement of the diaphragm provides the indication. For example, in an altimeter indicating from zero to 35 or 40 thousand feet, the diaphragm itself expands only about $\frac{1}{4}''$.

The second type of pressure-actuated instrument is the common, or well known bourdon tube. This is a tube formed in an arc and usually made of elliptical cross section. One end of the tube is solidly anchored, leaving the other end free to move. As pressure enters or leaves the anchored portion of the tube, the out or free end will expand or contract.

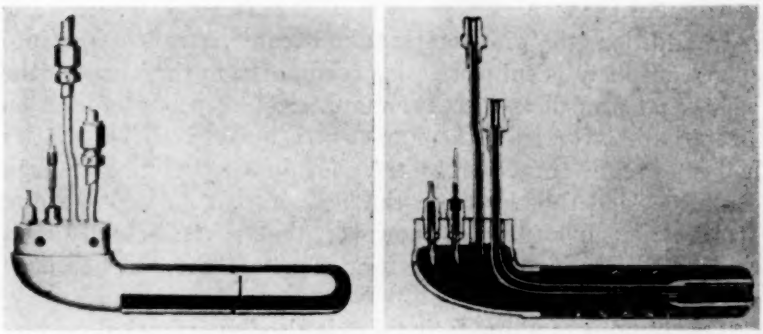


FIG. 1. The pitot static tube.

b. Pitot Static Tubes

The purpose of the pitot static tube is to obtain both impact, or total head pressure, and static air pressure by means of projecting into the atmosphere. These two pressures then are used to permit several instruments to provide the required indications. The instruments commonly actuated by the pressures obtained from the pitot static tube are the air speed indicator, the rate of climb indicator, and the altimeter.

Briefly, the pitot static tube as used in aircraft is as illustrated in Fig. 1. The leading edge projects in the direction of the line of flight. Impact pressure then is obtained at the most forward point and carried into the pressure line. Normally pressure of the surrounding air is admitted through the holes or slots at a point

somewhat aft of the leading tube and is carried into the static line. The pressures thus obtained are used in two ways. The total head or impact pressure can be used to actuate those instruments which need impact pressure whereas the static pressure may be used for those that require static pressure only. On some instruments, where both static and total, or impact pressures are required, the difference between the two pressures is used to obtain satisfactory pressure differential indications.

There are several problems which must be closely watched in the design of pitot static tubes in aircraft. One is the location of the pitot static tube on the airplane. While this is generally true of all pitot static tubes, it is extremely important in aircraft installation. Improper location of the tube itself, particularly with reference to exciting turbulence, or improper attitude with respect to the line of flight, will give erroneous readings at the instrument.

In addition, the pitot static tube because it projects out into the atmosphere is subject to ice accumulation the same as the wings and propellers are. Therefore, existing tubes as used on aircraft embody within them an electric heater coil. This heater coil is normally turned on by the pilot prior to entering an icing condition, and thus heats up the head so that no ice can form. It develops sufficient heat, however, that it can actually melt the ice if it is inadvertently formed before the coil has been turned on.

The draining of pitot static tubes is also important as in flying through rain water would be picked up by the total pressure tube and this would also give erroneous readings. One manner of having water drainage or elimination is the use of a deflector shield located as a forward or frontal plate to the actual pressure tube. The large chamber picks up the impact pressure and delivers it to the tube through the side opening. The enlarged impact chamber is drained through a small line as shown in the figure. No water then can enter the pressure tube. The static pressure inlets automatically drain through the small holes or slots through the side.

c. The Altimeter or Altitude Measuring Instruments

This unit determines the pressure altitude at which an airplane is flying. It determines the altitude by means of measuring the atmospheric pressure directly surrounding the aircraft, being similar to an aneroid barometer. The altimeter using an

established standard scale, indicates in thousands of feet, the altitude pressure.

The base of this scale is normally the sea level pressure of 29.92″ of mercury at 59°F. Generally the pressure for this instrument is taken from the static pressure inlet of the pitot tube. Because actual atmospheric pressure for any given altitude nearly always differs from the standard pressure on which the instrument is based, there is a need then to contain within the altimeter some device for adjusting it, where possible, to varying standards such that there will be a reasonably satisfactory approximation of the real altitude above sea level for all conditions of flight. This is accomplished normally by means of a barometric pressure scale in the instrument which can be adjusted by the pilot to agree with the pressure represented at any point

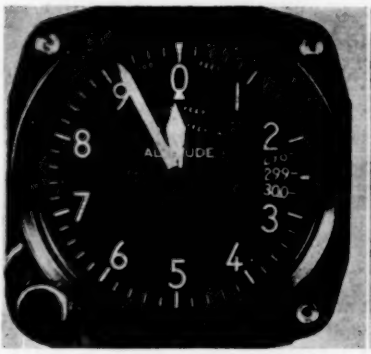


FIG. 2. A typical altimeter.

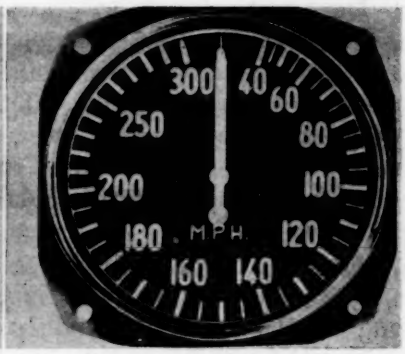


FIG. 3. Air speed indicator.

or station. As an example, suppose an airplane takes off from an airport at sea level. The barometric pressure reads exactly 29.92. The airplane proceeds in flight and while en route, by means of communication with radio and weather stations, the pilot is advised that the barometric pressure at the sea level airport at which he is to land is 29″. The pilot by means of a little knob adjusts the barometric pressure scale to 29″. This actuates a system of gears which shift the indicator to a corrected altitude position such that when the airplane actually lands upon this airport, the altimeter gives a zero altitude indication.

A typical altimeter is shown in Fig. 2. As the outside pressure changes, the aneroid expands or contracts, actuating a lever

mechanism, which in turn rotates the pointer. As an airplane climbs the decreasing atmospheric pressure expands the diaphragm rotating the pointer which shows an increasing altitude. This procedure is the opposite as the airplane descends.

d. Air Speed Indicator Instruments

The air speed indicator is to the airplane what the speedometer is to the automobile, with the exception that the speedometer always registers the true ground speed at which the automobile is traveling, while the airspeed indicator gives what is known as "indicated" air speed. For all purposes of navigation in terms of getting true air speed or true ground speed the indicated reading on the air speed instrument must be converted to act for atmospheric pressure changes and for temperature changes.

The air speed indicated, however, is more important to an airplane than the speedometer is to an automobile in that there are very positive ranges of air speeds which are related to efficiency of operation and safety, such as minimum or stall speed, which means that the airplane operated at any speed slower than this will become uncontrollable. There is also a high speed value which the airplane must not exceed which may be defined by either the structural characteristics of the airplane, or its controllability.

This instrument as shown in Fig. 3 uses both total pressure and static pressure to obtain its indications. It is actually a differential pressure gauge, which measures the difference between the two pressures as supplied by the pitot static tube and converts this into a miles per hour indication. As the speed of the airplane becomes greater, the impact pressure would be greater which causes an increase in the differential between the impact and static pressures. This is transmitted to the aneroid, which by a lever mechanism rotates the pointer of the instrument to show a higher value.

e. Rate of Climb Indicator

This instrument does exactly what the name implies: it indicates the rate of climb, or rate of descent of an airplane. A typical instrument is as shown in Fig. 4. The indications are read directly in feet per minute. The instrument serves several purposes. One, that it gives an approximate indication of actual rate of climb or rate of descent that the airplane may be per-

forming and in addition gives an indication to the pilot as to his level flight attitude. That is, if the instrument stays at zero during a level flight operation, he is maintaining a uniform altitude. This is particularly important for flight in overcast clouds or fog, as the instrument when it varies in either direction from the zero point, indicates to the pilot what slight correction he must make in the flight of the airplane to adjust the craft so it maintains a uniform altitude. Inasmuch as the indicator shows the actual rate of climb or rate of descent, it is also used as a limit means such that the pilot does not exceed rates of climb or rates of descent which might be objectionable to passenger comfort. This instrument gives an immediate indication of the rates of climb and rates of descent and may be checked with any change in altitude as may be shown on the altimeter for a given period of time.

The unit comprised of two chambers, one a pressure sensitive diaphragm and the other the airtight case of the instrument, is actuated by static pressure, generally received from the pitot tube. As the airplane climbs or atmospheric pressure is reduced, the diaphragm itself loses pressure. Being in an air tight case, however, the pressure surrounding the diaphragm remains approximately at the same value of the original atmospheric pressure inasmuch as the volume of air in the case itself is so controlled that it changes very slowly. These differences in pressure cause the diaphragm to expand or contract, giving a resultant indication on the instrument. Because the diaphragm is vented directly to the atmosphere, it stays at atmospheric pressure almost all the time while the pressure inside the case increases or decreases very slowly because atmospheric pressure to it is slowed down by the capillary tube. When the airplane assumes the level flight attitude regardless of altitude, the pressure in the two chambers becomes equalized and thus the instrument will show zero rate of climb in flight.

f. Turn and Bank Indicators

The Turn and Bank is an instrument that indicates the turning of the airplane and its approximate angle of bank. The instrument itself is really two separate functioning units in one. They are both placed in the same instrument, however, because the pilots use the indications together in order to coordinate the turn and bank characteristics of the craft.

A photograph of a turn and bank instrument is shown in Fig.

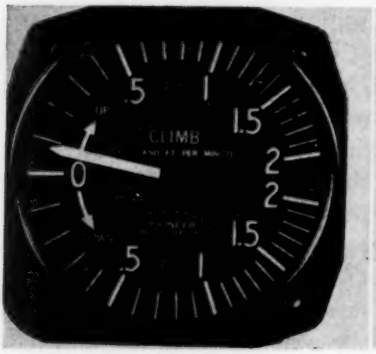


FIG. 4. Rate of climb indicator.

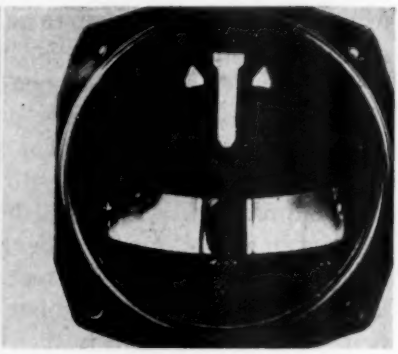


FIG. 5. A turn and back indicator.

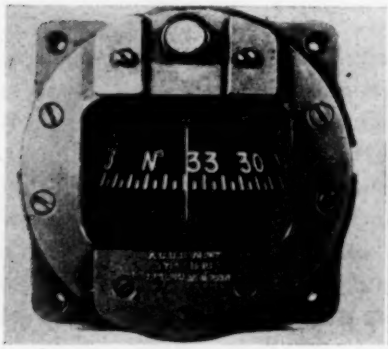


FIG. 6. Magnetic compass.

FIG. 7. The tachometer.

FIG. 8. A manifold pressure gauge.

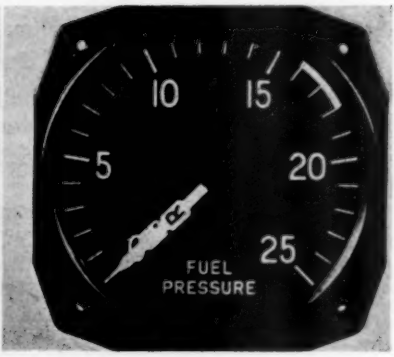


FIG. 9. A fuel pressure gauge.

5. The lower portion which houses a small ball in a covered glass tube is the bank indicator. The upper portion with the indications and the pointer is the turn indicator.

On the bank portion of the unit, the ball which is called an inclinometer ball is free to roll in the covered glass tube, the tube itself being filled with a clear liquid to provide dampening and to smooth out the movement of the ball. As the airplane is banked to either the left or right, the ball being actuated by gravity rolls either to the left or right. In a banking turn actually two forces act upon the ball. One is gravity, tending to move the ball toward the low wing, and the other is centrifugal force, tending to pull the ball away from the low wing side and in the direction of the high wing side. This means that when a perfectly banked turn is being made, gravity and centrifugal force are balanced and, therefore, the ball will stay in the center. However, if one wing is lower or higher than it should be for a perfectly banked turn, either one force or the other will cause the ball to move from its center position and the direction in which it moves will indicate to the pilot what correction he should make in turns of bank to put the airplane in an attitude of perfect turn.

The turn indicator portion of this instrument is considerably more complicated. The instrument has two reference marks. When the airplane is put into a turn, as the pointer lines up directly with either of the reference marks the ariplane is turning in this particular direction at a rate of exactly 180° per minute. The principle used in actuating this instrument is that of a gyroscope. The peculiar properties of gyroscopes called "precession" are used to make the turn indicator effective. A gyrowheel is always spinning at a very high rate of speed about a horizontal axis, its line of travel being in the same direction as that of the airplane. However, when the airplane turns the gyrowheel attempts to keep right on spinning in the same straight line as before, because of the characteristic precession action. However, the effective result is that the gyro-assembly, or what is known as the gimbel frame which supports the gyro, rotates about its axis with the entire assembly turning over on its side. These movements of the gyroscope are transmitted to the pointer. Balancing this is a centralizing or center spring which always returns the pointer to the zero position. This spring is balanced against the force of the gyro when it tips on its side or precesses and thus allows the rest of the mechanism

to move only the exact amount proportional to the rate at which the turn is being made.

g. Magnetic Compass

The compass (see Fig. 6) is the same in principle as all other general compasses in that it indicates the direction in which an airplane is flying with respect to the magnetic north pole. The principles of magnets and magnetic compasses need no discussion in this paper as they are well known. A short discussion on the design of the magnetic compass itself as a unit, however, may be desirable. The compass usually has two steel north seeking magnets. Magnets are attached to the bottom of a float, one on each side. The float itself pivots about a small jewel in the center, and a magnetic card or direction indicator is mounted to the float. The enclosed case of the magnet is filled with a liquid, the purpose being to reduce the effective weight of assembly and minimize the pressure on the pivot point giving more sensitive indications. This liquid also dampens the indicator so that the compass card will hold steady. A flexible diaphragm is also incorporated in the instrument together with what is known as an "expansion chamber" to counter-act liquid expansion which may occur with temperature changes so the effective pressure of the liquid in which the mechanism of the compass floats is relatively constant.

2. Power Plant Instrumentation

a. The Tachometer

Of prime importance to the pilot in operating his airplane is r.p.m., or revolutions per minute of the engine. There are in use today two types of tachometers, one the centrifugal type and the other the electrical type. A flexible cable is used in the centrifugal unit to transmit the rotation of the crankshaft to the shaft of the tachometer.

The tachometer of the centrifugal type consists essentially of a governing system and a linkage system. Fig. 7 shows the instrument. By means of the flexible shaft from the engine the tachometer drive shaft spins, rotating a large gear. This gear in turn is used to rotate the governor mechanism at high speed. The whirling weight, or governing assembly, spins around the shaft of the unit and the centrifugal force thus exerted upon the weights causes them to act exactly as a governor, the weights flying farther and farther apart, the faster the shaft

rotates. With the weights in the out position, the bottom unit of the governor assembly slides upward, squeezing together a spring (which is mounted on the shaft). The distance this spring moves is a direct measure of the engine speed, and the motion of the spring is converted into a pointer indication by means of a linkage.

The electrical tachometer incorporates a self-starting synchronous motor and an alternator. The alternator is connected to the tachometer drive shaft of the engine. As the engine turns over the alternator drive shaft spins and with it spins a rotor. This latter unit rotates inside a stator coil thus developing an alternating current, the frequency of which varies directly with the revolutions of the aircraft engine. The current thus produced is transmitted to the synchronous motor which is a part of the electrical tachometer instrument itself, and this motor operating the r.p.m. linkage and the pointer duplicates precisely the speed of the alternator which may be mounted on the engine. This principle of transmitting indication is being used in many new instruments.

b. Manifold Pressure Gauges

The second extremely important instrument to the pilot, indicating to him the proper functioning of the engine, is the manifold pressure gauge. This gauge indicates the pressure existing inside the intake manifold and, as in the case of the tachometer, is essentially for the safety and effective operation of the engine. Inasmuch as nearly all commercial transport engines are of the supercharged type at the present time, the discussion here will center about manifold pressure gauges with this type of engine.

The supercharger enables an engine to deliver its designed horsepower during flight at high altitudes. For a maximum or high power output the explosive charge in the cylinder must be maintained at a specific weight and this charge is comprised of gasoline and air. Air decreases in density as flight is made at high altitudes. Therefore, the weight of the air and the effective explosion in the airplane engine would drop unless some method is employed to keep the weight of the air normal. The supercharger actually compresses the air such that the weight is kept at the desired value. It will be seen here that at low altitudes it would be possible to over supercharge, or operate at too high pressures and the manifold pressure gauge then indicates to the

pilot when he might be exceeding the limits. In addition, the engine power that is actually available in flight is measured by both the r.p.m. and the manifold pressure. Therefore, the pilot can set to the desired power to maintain a certain air speed, or aircraft operation, by setting to one of several combinations of r.p.m., and manifold pressure. The manifold pressure gauge then helps him set to these desired powers.

A manifold pressure gauge as shown in Fig. 8 incorporates two aneroids or diaphragms plus a linkage system to actuate the pointer. The aneroids or diaphragms are evacuated and therefore have no pressure within them. Pressure from the intake manifold is introduced to the inside of the case or housing body and the diaphragm collapses as this pressure becomes increased. As the diaphragm collapses a force is exerted on the linkage in such a manner that the pointer is actuated through a linkage. Naturally as the manifold pressure or pressure introduced to the instrument from an outside source drops, the diaphragm will expand reversing the action of the linkage. The differential between the actual pressure in the intake manifold and the evacuated diaphragm is what is measured as the manifold pressure of the engine.

c. Fuel and Oil Indicating Instruments

In addition on aircraft engines it is necessary to have indication of the oil pressure, the fuel pressure, and the oil temperature in order that the engine may be satisfactorily and safely operated. The fuel pressure instrument as shown in Fig. 9, which is typical, is generally of the bourdon tube type units, which have been explained in the general section preceding.

3. Accessory Instruments

These instruments comprise those used either for determining that the elements which contribute to the operation of other instruments are within satisfactory limits, or instruments used in the determination of the performance of accessory equipment, such as cabin superchargers, steam heating systems, etc.

Instruments of this type are the suction gauge, pressure warning units, and other pressure measuring devices might fall into this class.

a. The Suction Gauge

Several aircraft instruments such as the turn and bank indi-

cator and the automatic pilot contain a gyroscope which is driven by an air stream. This air stream is set in motion through suction which is supplied by an engine pump, or a Venturi Tube. The suction gauge shows the exact amount of suction being developed.

The unit consists of a diaphragm which is a pressure sensitive unit and measures the variation in suction. These variations are then transmitted by means of a linkage system to the pointer.

b. Pressure Warning Units

In order that the pilot's attention could be immediately called to loss of oil or fuel pressure, pressure warning units are installed in these systems. These instruments actuate warning lights which go on at the time pressure is below or above normal. Two typical types of warning units that are used for this are as follows:

(1) A unit comprised essentially of a pressure sensitive bourdon tube and a commutator contact assembly. When pressure drops below a specified limit the mechanism completes an electrical circuit.

On some warning units such as fuel pressure warning units, the instrument may consist of a fuel chamber, a pressure sensitive diaphragm, a bellows, and two contacts. When fuel enters the instrument the diaphragm which forms one wall of the assembly expands in such a nature that the two electrical contacts (one which is mounted stationary and one which is movable), are apart. As the fuel pressure decreases, however, the diaphragm contracts, moving the arm such that the contacts come together, close the electrical circuit, and light the warning light. The purpose of the bellows surrounding the contacts is to prevent fuel or oil vapor from reaching the electrical contact in the event there should be a leak in the diaphragm.

(*To be continued*)

REFRIGERATED PACKAGE FOR FRONT LINE TROOPS

Refrigerated package is the term applied to an eight-foot-long metal container for use in bringing fresh food to frontline troops. It has a gasoline-powered cooling unit and twin slabs seven feet long. The latter are filled with a special freezing solution and house the cooling coils.

SELLING MATHEMATICS*

WALTER H. CARNAHAN
Purdue University, Lafayette, Indiana

As teachers of mathematics we are dealing with the most powerful and beautiful subject in the world. It is not only our privilege to believe this statement but it is our obligation to believe it. It is to be hoped that teachers of English and music and other subjects believe this concerning the subjects which they teach, but we shall leave them to present the advantages of their subjects while we concern ourselves for a time with those of mathematics.

Any teacher of mathematics is losing much of the joy of his work if he fails to sense the unlimited power and beauty of the subject and to transmit some realization of this to his pupils. In that school of yours there is some girl or boy who more or less clearly senses these qualities of mathematics. He or she is to you a constant source of joy and a complete justification of your labors. Wouldn't it be glorious if, say, half of our students were sold on the subject to the extent of being glad to devote themselves to their work in a manner to realize more fully its power and beauty?

It is one of our duties as teachers of mathematics to sell the subjects to our students. Time given to this work pays large dividends. There are definite procedures by which this selling of the subject can be done, and it is the purpose of this paper to point out some of them.

In Henrich Willem Van Loon's *Lives* he tells of sending to the land of the dead a dinner invitation addressed to "The Greatest Inventor of All Time." He did not know who might appear in response to the invitation. Would it be Archimedes? Galileo? Edison? Marconi? On the day set for the dinner, the cook prepared a meal of fried chicken and all the trimmings. At the dinner hour, Van Loon stepped out onto the street of his little Dutch village to look for his guest, leaving the door open behind him. He saw no one on the street, but when he returned to the dining room, he found that his guest had slipped in through the open door and was at the table ungracefully devouring the food. Do you remember the scene? It was an ape-like creature of

* Read at the Mathematics Sectional Meetings of the Northwestern Teachers Association and the Southwestern Teachers Association of Indiana, Oct. 26 and 27, 1944.

millions of years ago, the first ancestor of man, says Van Loon. Beside him was his invention, a sharp stone for killing his enemies. It was the first device by which mankind made use of a material thing as a tool to gain his ends

We have come a long way since that first ape discovered the use of a stone as a weapon but in material things we still follow the same road, namely, the use of natural objects to serve our will. We want to influence the thinking of many men, so we put together bits of metal, wood, ink and paper and make a printing press to turn out books. We want to know intimately about the sun, moon, planets and stars, so we assemble some metal and glass and make telescopes. We want to transmit information quickly from person to person, so we put together fabric, metals, and rubber and make telegraphs and telephones. We want to hear music and words of wisdom being produced hundreds of miles away, so again we put together bits of metal, plastic, rubber, wood and glass and make radios. We want to travel to distant places with a minimum expenditure of time, and so once more we assemble some metal, plastic, rubber and fabric and make for ourselves automobiles and airplanes.

These days we hear much about radar. By radar a plane can be located through cloud and darkness. Let me tell you how to make a radar instrument. As with the other instruments mentioned, you get some metal, plastic, wood and glass, put them together, and you have your instrument. Now you begin to ask questions. What shape? How long? How thick? In what proportions? How many? Where? In other words, you want me to become mathematical and you well know that without mathematics to give quantitative specifications I can tell you nothing useful about radar or any other scientific invention or discovery.

One of the fundamental instincts of mankind is to create, and the more highly developed we become, the more urgent is this instinct. By the act of creation (discovery, invention), we come to feel akin to God, the Great Creator. There is not a normal, intelligent boy or girl in your school who does not want to create something, be it a poem, a story, an oration, a machine, a new understanding of nature or the constitution and behavior of material things. And that creative desire is our hope of survival and improvement as a nation in this very competitive world. Some boy in your school wants to have a part in the creative development of television; some girl wants to contribute to our understanding of the value of color and form in the art of home

making; some one wants to create a safer, more economical airplane; some one wants to be a research scientist, a pure mathematician, a designer of better machines, an inventor of new devices to give man more and better mechanical servants, to extend his dominion over the world of material things. What adventure lies ahead of young folks filled with the desire to understand, create, develop and apply the principle of physics, chemistry and other sciences. Let us help them to see the possibilities and encourage them to have a part in their realization. One of the very first things to be understood by young persons who would have a part in all this is that it is in a field around which is a high wall that has only one gate and that this gate is locked and has but one key, and this key is mathematics. Aeronautics, and radio, and television, and metallurgical engineering, and chemical engineering, and civil engineering, and mechanical engineering, and research are sciences; and science has but one language which is mathematics.

Do you occasionally paint this picture for your students? Do you invite them to have a part in the greatness of the achievements of today and tomorrow? Do they realize something of the great power of mathematics? To develop this realization is one way to sell your subject.

The Great Teacher said, "Man cannot live by bread alone." May we elaborate and extend this statement and say "Man cannot live by airplanes, radio, television, automobiles, steam ships, and air conditioning alone." He is spiritual as well as physical, and a part of his spiritual nature is manifested in his esthetic sense. Man yearns for beauty, the beauty of flowers, the beauty of the sunset, the beauty of stars, the beauty of truth. It was Keats who said,

> "Truth is beauty, beauty truth;
> That is all ye know on earth
> And all ye need to know."

The truth of mathematics is established by logic, step by step, detail by detail. Granting its postulates, the truth of its conclusions is inescapable, and consequently its beauty is ever about those who master it, whether it be calculus or arithmetic, pure mathematics or applied. But the fact that its beauty is constantly about the learner is no assurance that he will see it, just as the beauty of the sunset fails to reach the consciousness of many persons. Realization of the beauty of the sunset or of mathematics is something that has to be cultivated. The artist

catches the beauty of the sunset and puts it on the canvas and thus we learn to see what he saw. The poet puts it into words and thus our eyes are opened. And so it is with the beauty of mathematics; if the child is to see it, you and I will have to see it first and point it out to him over and over.

The homemaker hangs a drape on a rod at the top of the window and lets it hang free. Gravity adjusts it in straight, parallel lines, and thus mathematics is an essential part of its beauty. Perhaps she puts a tie around it and fastens it back at the bottom. Nature now adjusts it in a number of catenary curves, and again this mathematics is as much a part of its beauty as the color or weave. The engineer scientifically designs a suspension bridge and the mighty cables in the finished bridge are parabolas. We look and say the bridge is beautiful. Its beauty is in its mathematics. It is quite possible for your students of mathematics and mine to take five years of the subject in elementary school and four years in high school and never see these beauties unless you and I point them out.

There is a force which attracts any two material objects. That is a physical truth which must have been vaguely sensed by the first child that fell down and bruised himself. This attracting force is greater between large objects than between small ones, and between those that are close together than those far apart. So much of the principle of gravitation may be immediately acceptable to the intelligent person, but no law has so far been formulated. The law of Universal Gravitation as stated by Isaac Newton is this: Every particle in the universe attracts every other particle with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. As a physical principle, this statement is complete, but as a tool for solving the problems of the solar system, one thing is lacking. The mathematician (who may also be the physicist) now takes over and writes

$$F = \frac{KM_1M_2}{s^2}.$$

The five quantitative symbols combined into this simple and convenient form become a powerful tool which can be used to help give us mastery over the material objects about us, even the sun, moon and stars. This is one more example of the beauty of mathematics. Even non-mathematicians can appreciate this.

In the presence of this beauty, the poet Pope was moved to write

> "Nature and nature's laws lay hid in night.
> God said, 'Let Newton be,'
> And all was light."

Our pupils should appreciate such beauty of mathematics, but you and I will have to help them to it. Thus we can sell the subject to them.

The first step in selling mathematics to our students is to do a thorough job of selling it to ourselves. If we are in any doubt about whether we have done this, there are certain questions which we can ask ourselves to make sure. Do I occasionally take down one of my college mathematics texts and solve a few problems to maintain acquaintance with the subject? Do I buy books dealing with the history, development, entertainment and cultural phases of mathematics? Do I read such books habitually? Do I subscribe to magazines dealing with mathematics and the teaching of the subject? Do I read them? Do I love to teach the subject? Do I look for mathematics in the objects about me, in bridges, in buildings, in decorations, in machines, in nature? Do I look for mathematics in newspapers and magazines? Do I clip suggestive pictures and news items? Do I see to it that my school library has a growing collection of good mathematics books? I do not mean to imply that it is necessary to answer every one of these questions in the affirmative in order to say we are sold on the subject. But if the answer to every one of them is in the negative, I can hardly say I have a deep interest in it, and I can scarcely hope to sell it to my pupils.

Having sold the subject to myself, I am ready to begin a continuous program of selling it to my pupils. There are certain definite things which I can do. I can clip pictures and news items from papers and magazines, talk about them and post them in my room. I can have occasional reports by pupils on pertinent historical and biographical materials. I can organize a mathematics club to discuss interesting matters. I can get from manufacturers and government agencies charts and literature. I can make use of materials available in the Visual Aids Department of my state university. I can show slides and motion pictures available through commercial distributing agencies. I can be on the alert for opportunities to point out the power and beauty of mathematics. I can use strings, cards, paper cones, wire, chain, toys, puzzles to illustrate mathematical principles.

A word of caution about selling mathematics to students. Let's not overdo it. It would not be reasonable to devote as much as, say, ten percent of class time to the effort to sell the subject to students. A class period two or three times a semester, or five minutes once a week as occasion arises would be a fair amount of time to spend on this. And we should be careful that we do not sell the subject on a permanent basis to the wrong students. There is good little Joe to whom it is all Greek and always will be so. Don't try to make a mathematician out of Joe; let him go on happily playing his saxophone. And then there is sweet little Dorothy who can never seem to find the handle by which one takes hold of mathematics. Don't try to sell the subject of mathematics to her permanently. Let her go on contentedly participating in amateur dramatics. There is a place in the world for Joe and for Dorothy. Let's concentrate on selling mathematics to Harry who wants to be a research scientist and has it in him, or to John who wants to be an engineer and has what it takes, or to Alice who has mathematical ability and does not know exactly what she wants to do.

The war has compelled us to put a new value on mathematics. But the war is an incident. It will, please God, soon be over. However, there are peace time uses for mathematics far more numerous and useful than those of war. In preparation for our part in the affairs of the new day, let us have more and better mathematics.

COIL SPRING AND SHOCK ABSORBER UNDER SEAT OF FARM TRACTOR EASES WORK OF DRIVER

A special coil spring, and a shock absorber, is the basis of a new suspension-type tractor seat which will take all the jolts out of riding the farm tractor over rough plowed land and ease the work of the driver. It may perhaps decrease the high degree of kidney and skeletal disorders among farmers blamed on the all-day-long tractor jarring. The new tractor seat was developed here by the Monroe Auto Equipment Company, which developed and has made thousands of seats for war tanks.

The coil spring is placed directly under the driver's seat, and the triple-action hydraulic shock absorber at the rear. The absorber is similar to those commonly used in automobiles. Together the two devices give stability that enables the rider to stay level while the tractor bobs over rough ground.

The construction of the new device is simple and inexpensive, and it can be installed on all makes of tractors. It can also be applied to truck seats.

RADIO IN POST-WAR EDUCATION*

NATHAN A. NEAL
Radio Station WBOE, Board of Education, Cleveland, Ohio

When your chairman invited this paper dealing with Radio Education it seemed possible that the topic might fit into the general convention theme, "Post-War Planning." Recent developments indicate that all types of radio education, and particularly public school radio broadcasting, are growing and are certain to have a place in the educational field after the War. In this paper an attempt will be made to discuss some of the kinds of educational radio activities which are already in practice, and to do a bit of amateur crystal gazing in the field.

Educators in general are familiar with programs such as "The World's Great Novels," "We Came This Way," "Home is What You Make It," "University of Chicago Round Table," "Cavalcade of America," "Words and War," and others, all of which are broadcast regularly over the National Broadcasting Company network. Looking again at these titles we find materials dealing with literature, history, and various economic, political, *social* and *scientific* aspects of current events. Most of these programs may be found listed in your daily newspaper. Many of you have heard them and recommended them to your pupils, and others may wish to do so. Another radio network, the Columbia Broadcasting System, conducts a "School of the Air" with regularly scheduled thirty minute educational broadcasts five days of each week. These broadcasts, intended for both adult and school listening, deal with science, music, geography, literature, and current topics. This same network conducts a forum discussion program called "The Peoples Platform," an excellent children's series entitled "Let's Pretend," an "Invitation to Learning" series, and other carefully planned and well produced educational programs. From the Blue Network we have the "Town Meeting of the Air," "March of Time," "Doctor Talks It Over," and others. "Freedom of Opportunity," the "Human Adventure" series, and exchanges with the British Broadcasting Company are a few of the educational programs presented by the Mutual Broadcasting System. If music programs are included as educational,

* Prepared for presentation before The Senior High School Group Meeting of the Central Association of Science and Mathematics Teachers Convention, Nov. 25, 1944.

this entire list could be multiplied two or three fold. True enough not all of these educational programs are available to every pupil and teacher in the United States. However, some of them are available in every school district. Most of them may be heard in any metropolitcan area. It is axiomatic that your local radio station manager will carry any educational program offered by his particular network connection if enough people demand the program in writing. Thus almost any wide awake science or mathematics teacher may take steps to encourage some good radio listening in his community. It seems to the writer that a very good case may be made for the point of view that every teacher is concerned with radio education.

After this brief examination of educational programs available over commercially operated networks and standard broadcast stations, let us turn to the fields of educational radio activities broadcast over stations owned and operated by colleges, universities, and public school systems. For centuries it has been considered necessary to go to a center of learning—a college or university campus—for college education. Radio however, makes it possible for the institution to broadcast from a center to learners wherever they may live. Radio holds the possibility of expanding the limits of the campus to the limits of program reception.

Today about thirty colleges and universities own and operate radio stations. These are not concentrated in any one geographical region but are spread over the entire country. More than five hundred colleges and universities offer courses in radio. About 90 percent of all the institutions of higher learning in the country make use of radio in one or more ways. Numerous colleges and universities employ radio directors and staffs to develop programs even though the institution itself does not own a station. Miscellaneous Bulletin No. 7, Federal Security Agency, U. S. Office of Education indicates that there are six principal uses which colleges and universities make of radio: (1) schools of the air to serve elementary and secondary schools, (2) general adult education programs, (3) service to special groups such as farmers, (4) student programs, (5) public relations programs and (6) sports programs.

Examination of these six types of activities indicates rather wide spread use of schools of the air. A number of state universities serve their respective commonwealths with a wide variety of educational broadcasts ranging from elementary to college

levels throughout the entire school year. Most of these programs supplement the work of the classroom teacher. In rare instances, such as direct teaching in the field of music, radio may serve as a teacher or assistant teacher.

In the field of adult education by radio most authorities are in agreement that there is much to be learned. In some instances, radio study clubs have been successfully organized. Printed materials have been distributed to supplement such radio activities. Consumer advice programs, physical exercises, forums, news, literature and other topics diverse in nature and special in audience may be listed among the efforts in adult education by radio.

Commercial radio stations, in general, have found it unprofitable to attempt to reach small audiences or groups with special interests. Education, however, tends to sub-divide learners into groups in order to insure efficiency in the educational process. When an institution uses its own station it can provide programs for smaller special groups. Examples of such service include Greek literature programs, child study programs, Morse code lessons, farm programs, programs to teachers in a state wide community and others. It has been said that the educational station may use a rifle-like approach to a limited audience with profitable results in terms of its objectives, whereas commercial stations generally must use the shot-gun approach in attempting to reach the widest possible audience.

Sports programs are common over college and university stations. Wholesome interest in organized athletics and individual physical activities may be developed and promoted through the use of educational stations in broadcasting a variety of local sports events.

In general, when colleges use radio there is a tendency to concentrate on broadcasting to groups which are not on the campus. There have been some programs for students, however, which have been useful in enabling citizens and home folks to know something of what the boys and girls are doing in school. This is one type of public relations program and here we arrive at a popular and useful educational radio activity. Most institutions which have operated stations over a period of years consider radio indispensable to their public relations programs.

At this point, as the discussion turns from university stations to those owned and operated by public school systems, let us look at an exact definition of the term "non-commercial educa-

tion broadcast station." "The term, 'non-commercial educational broadcast station' means a station licensed to an organized nonprofit educational agency for the advancement of its educational work and for the transmission of educational and entertainment programs to the general public." Miscellaneous Bulletin No. 7, already mentioned, devotes a section to the topic, "How Can an FM Educational Station be Used." This introduces a new term which calls for further definition. FM is the abbreviation for frequency modulation. It is a method of transmitting radio programs which differs from the AM or amplitude type of broadcasting utilized by standard broadcast stations today. FM is less subject to static and interference of all types—thunderstorms, elevators, generators, and a variety of man-made interferences—than is reception of amplitude modulation broadcasts. FM gives high fidelity programs. More of what goes into the microphone comes into the home or classroom through the receiving set. The channels assigned to FM stations are sufficiently wide to provide freedom from interference of nearby stations in the radio spectrum.

Five frequency modulation radio channels have been set aside by the Federal Communications Commission for the exclusive use of education. The number and position of these channels are being reconsidered at the present moment. Recent hearings before the Federal Communications Commission have brought out the need for a greater number of channels for educational uses. Perhaps you are thinking what would we do with an FM station if we had one in our school system. A partial answer may be found by examining types of educational programs which have proved useful in the school systems which have been operating their own FM stations over varying periods of years. News and current events programs come high on the list. Every school and educational station has a variety of these programs for different pupil levels. Radio current events programs not only present news items which are especially selected and reworded in light of the capacity of children of different age levels, but they also relate the news to subjects in the curriculum such as science, social studies, geography, history, and others. Most teachers are faced with the problem of keeping their students abreast of the time regardless of what subject matter area is involved. The radio is an important tool for keeping up to date in any classroom.

Subject motivation programs have been numerous. Mathe-

matics, reading, science, art, and handicraft are a few areas which have been successfully motivated and made more interesting and worthwhile to the pupil through the use of radio. Superintendent Charles H. Lake of the Cleveland Public Schools is quoted as saying, "Our exeprience in Cleveland indicates that there is no subject in the curriculum that cannot derive important benefits from educational radio broadcasting." Supplementary teaching aid programs are equally important. Often classroom instruction may be enriched by supplemental material presented by radio. Here again there are no subject matter field limits. A specific example of this type of enrichment has resulted from an assignment which the writer has had for the past several semesters. This deals with supplementary or enrichment programs in senior high school science.*

The urgent need for an intensified preinduction program of instruction in science has been a major factor in shaping science broadcasts in the senior high school field in Cleveland during the war period. Pre-induction science teaching at the senior high school levels has concerned itself with giving the pupil scientific background which will enable him to cope with the occupational problems of military service. Electricity, mechanics, communications, and aeronautics are fields which have been indicated by military authorities as of greatest importance for preinduction emphasis. Hence, in September 1942, a program of wartime broadcasting for senior high school science pupils was inaugurated to include materials in these pre-induction areas. During the first semester of the 1942–1943 school year the program was given over entirely to broadcasts in the field of aeronautics under the general title, "So You're Going to Fly." Authorities in the community were brought to the school radio station to discuss topics such as: Commercial Aviation Since 1925; Flying "No See"; Flight Training of Army and Navy Cadets; Research in Aviation; Civil Air Patrol Activities; Advances in Airplane Manufacturing; and others. The experts who discussed these and other topics in broadcasts to senior high school pupils were obtained through the cooperation of the aviation editor of the *Cleveland Plain Dealer*. Two pupils selected from high school speech classes interviewed the aviation authorities. Prior to each weekly broadcast the aviation editor and a photographer from the newspaper accompanied

* Adapted from "Using Radio as a Tool of Science Instruction During the War Period," *Science Education*, Vol. 28, No. 3, pp. 150–154.

the two pupils to the place of business of the expert who was to speak and answer questions on the program. The newspaper carried pictures and a news story from the industrial or occupational setting related to the topic of each broadcast. Thus some of the industrial processes and essential war activities of the community were brought directly to high school pupils in the classroom. The news stories and pictures served to build interest on the part of pupils and teachers, and also as an intelligent form of interpretation of wartime school activities to the public.

During the semester following this initial effort at using radio as a tool of senior high school science instruction in wartime, a series entitled "Wings and Waves" was broadcast. These programs were divided equally between aviation and communications topics. Individual broadcasts were pointed up especially for class groups in which the radio materials would correlate closely with regular classroom activities. During the entire 1943–1944 school year programs for senior high school science classes were broadcast under the series title of "Science and the War Industries." Mechanical, electrical, and aeronautical topics of pre-induction significance were emphasized for class groups which were dealing with subject matter in these areas. Examples of weekly topics were: Precision Aircraft Instruments; Use of the Automatic Gyro-Pilot; Applications of Electronic Research; Electroplating in Wartime; Critical Metals in the War Industries; Storage Batteries at War; Synthetic Rubber Today; and others. The practice of bringing men on the job in industry into the classroom through the facilities of the school radio station has been continued under the same title during the current school year. Significant biological materials are now being included in the series. A weekly announcement in advance of each broadcast is sent to teachers and includes name of speaker, questions to be answered, vocabulary, bibliography, and appropriate diagrams or charts in some cases. An evaluation committee of senior high school science teachers meets regularly and furnishes guidance to those who prepare and produce the broadcasts. Industrial firms have shown a real desire to cooperate in arranging these programs. In almost every case top-notch authorities have been made available to present an authentic program and point of view to the pupils. Scripts are prepared well in advance of the date for each broadcast and are approved by the authority who is to make the

broadcast, as well as by the office of science supervision and the radio production staff. Without radio few if any pupils would be able to share the experience and knowledge of the key men on the job in industry. All broadcasts are fifteen minutes in length, and all broadcasts are repeated for classes in each period of the school day. There are about fifteen different programs each semester to senior high school science classes. Thus this single example of an enrichment type of educational broadcast, conducted over one school station, has included approximately seventy-five separate programs from September 1942 to the present date.

Other services of a school station include story telling for young children. The dramatic narration possible through story telling programs adapts itself for various age levels. Another important type of service is in the field of guidance. Here radio makes possible uniform standards of guidance in a school system. Programs may be planned to guide pupils in the last year of the elementary school in the important and often difficult decisions they must make in their adjustments to the junior high or senior high school program the following year. As indicated in the discussion of science broadcasts, competent authorities from a variety of fields may reach large numbers of pupils by means of a single radio broadcast. It is also true that each one of a series of broadcasts in a given subject matter field may place emphasis on the occupational aspects of that particular field. Some types of educational and occupational guidance may be given by radio so as to save large amounts of time. Every pupil concerned may have the advantage of hearing the most competent authority in various fields.

Both public and school libraries have made excellent use of radio programs to school and community listeners to stimulate use of library resources. In city school systems the radio has served as an in-service teacher training device. In Cleveland radio station WBOE has broadcast two in-service training programs—"Know Your Schools," which serves as "an oral house organ" helping teachers to understand the work of school departments, divisions, and bureaus, and "Keeping Up To Date," a review of outstanding books and periodicals produced in cooperation with the Cleveland Public Library. Occasionally, this educational station presents special programs for teachers' meetings on such subjects as income tax, Ohio laws of

particular interest to teachers, or what kind of a teacher parents admire.

Up to this point the discussion has been limited to live programs. Actually, recorded materials are likely to be more important and more time consuming for the educational station then are live programs. Selected network educational programs may be recorded and rebroadcast at suitable hours in terms of school schedules. Programs may be exchanged over unlimited distances by means of recordings. Recordings used once in a city wide broadcast may be made available to individual schools that wish to repeat the program for additional groups or more intensive study.

A school owned station is a stimulus to student talent in the fields of dramatic production and radio production, as well as for those interested in the technical aspects of broadcasting. Forums and discussion programs which originate in various schools may be broadcast over a central station into all the schools of a city or an entire region. Pupil discussion programs, in some cases, have led to adult groups requesting time on an educational station for similar forum activities. Community service programs may be popularized and made more useful through being publicized over an educational station into the schools of a community. Safety campaigns, spring clean ups, War savings programs, tin collections, War Chest drives, and many others could be listed in this area. This statement of activities which have taken place over educational radio stations could be extended through sports programs, holidays and special events programs, a variety of school public relations programs, radio lessons for handicapped children, and others. Any such list made by one individual is highly incomplete. Widely varying problems and solutions arise at different times and in different schools and communities.

So far, the discussion has been in terms of what has already taken place. Changes occur rapidly. Notwithstanding the hazards of prediction an attempt will be made here to look ahead briefly in the fields of frequency modulation, television, and facsimile broadcasting. The first of these, frequency modulation, has been mentioned and defined earlier in this discussion. This type of broadcasting with the technical advantages indicated earlier is almost certain to be of great importance in the industry in the years immediately following the War. Many applications

are on file by broadcasting companies and individual stations for FM licenses. Leaders in the industry estimate that between five hundred and one thousand new FM stations will be in operation within a few years following the end of the War. It is technically possible for as many as three thousand new stations to be established within the frequencies available for this kind of service. This may be compared with the present total of about nine hundred standard broadcast stations in the country. However, should anything like the number of stations predicted for commercial operation actually materialize during the early post war years, we shall see a far greater range in types of programs than is now the case. At present there is mainly one general radio public. If the number of stations were to be doubled or quadrupled recognition would be given to many different groups or "publics." In striving for recognition stations might strive to meet the tastes of various discriminating listener groups.

Somewhere in this picture the school station must find its place. As indicated earlier the place of the school station will in the main represent services which are complementary to those provided by commercial outlets. The educational broadcaster will need to learn early that the success of his efforts are not measured by the same standards that are applied to commercial radio. If such observations are well taken, then it is clear that the spread of frequency modulation broadcasting with the resulting increase in the number of local commercial stations presents a challenge to the school broadcaster. There will need to be centralized agencies so that superior scripts and transcriptions will become more readily available to the average school station. Perhaps different types of "packaged" program services will become available to educational broadcasters on somewhat the same basis as is true of certain types of visual aid materials in the schools today. The national networks will continue to take part in the future of education by radio. Nationally important events, the views of political and economic leaders, and topics of international concern will be available over the networks for adaptation by the alert educator.

The possible formation of networks of educational stations has been mentioned. In this connection the following statement was made by the Honorable John W. Studebaker, United States Commissioner of Education, before the Federal Communications Commission on October 13, 1944: "Information

received to date by the Office of Education indicates that plans are already being made, by responsible (and usually, officially constituted) planning committees in each of 28 different states to construct a sufficient number of educational FM stations, and to space them in such fashion, that every single school and every single home in the State will be able to receive educational broadcasts from at least one station. These 28 states represent about 51% of the total area of continental United States, and slightly more than three-fourths of its total population. In each of 6 other states, educational FM stations being planned locally by individual city school systems, colleges, and universities may be expected to provide educational program service to a substantial portion of the State population. This brings the total number of States in which there is concrete evidence of educational FM broadcast station planning up to 34." Thus Commissioner Studebaker has indicated that plans for such state wide organizations are definite in the case of more than half of the forty-eight states.

By using such facilities local education stations may exchange programs at will. The best materials from any one of a dozen or more stations in a given state might be made available for all pupils. Such steps may bring an enriched curriculum to smaller high schools. Standards of education in general may be improved. Matters of serious importance within a given state may be explained or discussed with uniform clarity before every pupil in the state. Through special programs for teachers which someone has already named "Institutes of the Air," the voice of education may be further magnified. Certainly tax payers may learn better the needs and accomplishments of their schools. Educational networks would reduce the time spent by local stations in program preparation and production. Individual groups would be able to spend a majority of their time on the type of thing at which each might be most efficient. Specialized talent in widely differing fields might be used to serve greater numbers. Miscellaneous Bulletin No. 7 states, "Shortly before the War, experiments successfully demonstrated the possibilities of linking FM stations without use of land wires. Radio beam relay service to connect FM transmitters remains on an experimental basis, but the close of the War may see relay beams authorized by the Federal Communications Commission for continuous use. Where two FM stations are not too distant from one another, one may pick up a program from the other

and rebroadcast the program on its own wave length. In New England, programs are exchanged at will among a group of six FM stations."

As this is written adult education looms more important as potential major activity of educational stations. Types already tried include late afternoon music programs, homemaker's chats, and programs utilizing abilities and talents of various community representatives. Dr. William B. Levenson, Directing Supervisor of Radio in the Cleveland Public Schools, in a statement before the Federal Communications Commission October 13, 1944, speaking of proposed adult programs over Cleveland's educational radio station said, "These are some of the programs we have in mind: 'Your Health,' 'Being a Parent,' 'First Aid,' 'Philosophy Through the Ages,' 'Frontiers of Science,' 'Meet the Expert,' 'Chamber Music,' 'Local Issues,' 'Current History.' As we see it, the school station can be of real service, not by attempting to do what commercial stations can do better, but rather by concentrating upon what they may not do."

Beyond the field of adult education there are other possible and probable services for school owned stations which catch the imagination of almost every one who inquires into the subject. There are announcements daily from a central headquarters to all points of a school system. Special emergencies may be handled without the loss of a moments time. Warnings of storms, epidemics, or disasters which may endanger the lives of children may be sent out at a moment's notice.

A second basic development in the broadcasting field is television. No doubt some of those present here today recall the demonstration of television which we had at the 1928 convention of the Central Association of Science and Mathematics Teachers on the campus of the University of Chicago. Sixteen years, perhaps you are thinking, and television is still around the corner. True but the art and science of television have turned several corners in the meantime. You know that television is actually here, technically speaking. There are stations which broadcast television programs regularly to limited numbers of receivers in the areas served. It is technically possible for each school room in a community to have a receiver and for pupils to view as well as hear an illustrated talk, a sound film, or a science demonstration. It is not likely that educational television will become available before the existence

of wide spread commercial television. It seems safe to forecast that television broadcasting will grow in the years following the war. It is evident that television production will be more costly than has been the case with radio production in the past. Larger staffs are necessary for both program production and technical operation. Cameras, lighting, and various properties must be assembled and scenery must be constructed, all in addition to the usual production procedures that we know in radio. Casts must memorize their lines, which means more work and longer rehearsals. Costumes must often be designed and made.

Perhaps films, both slide and motion picture, will become the backbone of television production. But even so, it is clear that numerous artistic and economic factors have yet to be solved after television is technically available. It is hazardous to forecast the place which television will have in the home and school ten or twenty years hence. Unlike the radio complete attention is required for television. The room must be darkened to see the picture. Certainly the busy housewife who enjoys her radio serials will not be able to replace them immediately with television. Some have urged that unwavering attention is possible only under special circumstances, such as in the theater, and that television belongs here. What are some of the educational implications of television? Various experiments have been tried. Lists of educational programs which have been televised may be obtained from the agencies which have produced them. Levenson in his forthcoming volume, *Educational Broadcasting*, says: "The use of television will provide the teacher with a potentially effective service but at the same time she will be confronted with an additional responsibility. If sight and sound plus actuality and color can enhance the emotional effect of the entertainer and the teacher, they can do the same for the demagogue. If television can more effectively spread knowledge, it can more effectively spread propaganda. The need for discrimination will be greater than ever. It would be unwise to assume that within a brief time television receivers will be as common in the classrooms as are radio sets today. Economic obstacles will operate here even to a greater degree. It will be interesting to see whether as consumers of television programs the schools repeat their experiences with radio. The first television units may be used in the school auditorium where several classes can enjoy the 'show.' As receiver costs decrease and as more pro-

grams become available a few teachers wishing to make better use of the programs will install receivers in their classrooms. Greater attention then will be given to the selection of programs and the development of utilization practices, and certainly many questions will have to be answered. For example, what effect will television have upon reading habits?"

Many school systems have used visual aids over a long period of years. The supply of slide film, charts, models, photographs, and silent and sound movies might be made available to larger groups at more frequent intervals through the medium of television. Such items might serve television in the future as the transcription or recording now serves radio. The United States Office of Education with the support of various educational instittions and organizations has requested the Federal Communications Commission to set aside two television channels for the exclusive use of education.

A third and less known basic development in the broadcasting field is facsimile. A simple definition of the term would indicate that facsimile is the broadcasting of printed material. Like television it involves a visible picture, but unlike television facsimile leaves a permanent copy of the original material. Technical broadcasting procedures for facsimile are not strikingly different from technics used in radio and television work. Drawings, maps, pictures, and almost any type of printed material may be transmitted with facsimile broadcasting equipment. Proponents of this art point out that a housewife listening to a cooking school program may also receive copies of the recipe by facsimile. A talk on dress design may be illustrated by photographs and even a copy of the pattern. News commentators may supply their listeners with maps, developing the map as the spoken story unfolds. The printed material is reproduced on a roll of paper by the receiving unit. Numerous possible applications including a variety of educational uses are immediately apparent. Modern units may deliver one thousand or more words of text a minute. This means that sixty thousand words or a good sized book, newspaper, or magazine could be transmitted completely within one hour. In the police and military services it is clear that facsimile may be of great importance through the transmission of maps, charts, blueprints, photographs and other materials. Through the use of facsimile it is technically possible for a householder to have his morning paper printed in his living room or radio

room while he sleeps. Facsimile and television combined would seem to add to radio all of the visual possibilities and technics which have come into the classroom in the form of visual aids. Other possibilities for school use might include the transmission of administrative announcements, lesson assignments, maps, and emergency materials.

Lest there be some alarm, it should be emphasized that no mechanical device is likely to eliminate the factors of effort and personal relationship from successful teaching and effective learning. It is quite safe to assume that more teachers rather than fewer will be needed in the future—the future which holds such broad and inspiring possibility for increased use of these new tools of education. Radio instruction when it comes on a wider scale must be integrated into the school life of the times.

BIBLIOGRAPHY

1. Levenson, Wm. B., *Educational Broadcasting* (Tentative Title), Farrar & Rinehart, New York (March 1945).
2. U. S. Office of Education, Federal Security Agency, Misc. No. 7, *FM for Education.*
3. MacLatchy, Josephine H., ed., *Education on the Air*, Yearbook of the Institute for Education by Radio, Columbus, Ohio, Ohio State University 1940–1944.
4. Studebaker, John W., *The Needs of Educational FM Broadcasting for Additional Channels*, Education for Victory, Volume 3, No. 9, November 3, 1944.
5. Journal of the Association for Education by Radio (Eight issues annually) 228 North La Salle St., Chicago, Ill.

DOCTORAL DISSERTATIONS

For the 11th consecutive year, DOCTORAL DISSERTATIONS ACCEPTED BY AMERICAN UNIVERSITIES makes its appearance, covering the doctoral dissertations appearing during 1943–1944 (The H. W. Wilson Company, 88 pages, cloth, $2.50). Dissertations are arranged as before in seven main subject divisions, with many sub-divisions, all those of any one university appearing together. A few changes have been made in some of the sub-divisions. Metallurgy has been moved from the Earth Sciences to the Physical Sciences where it stands close to Engineering. Geophysics has been added to the Earth Sciences. The title of the last division has been changed from Literature and Art to Humanities. Otherwise the features of previous volumes have been retained.

The volume again shows the impact of the war. A total of 2117 dissertations are listed, the lowest figure since 1931, showing to what an extent the war has reduced the annual volume of doctors graduating from the universities of the United States and Canada. The effect of the war is also noticeable in the number of dissertation titles withheld because they were "secret war research," 65 being so reported as against 43 in 1943. Also, in 1944 only 39 institutions required the printing of dissertations, "in full or in part" as against 44 for 1943. The usual tables giving information as to the publication and preserving, and the abstracting, of doctoral dissertations, and other statistical information, have been included.

SINE CURVES

A. R. JERBERT
University of Washington, Seattle, Wash.

Alternate proofs of Mathematical theorems are frequently of considerable value because of the difference in approach which enables each one to illuminate a different facet of the central fact which is to be demonstrated. For similar reasons it is highly desirable that a student be made familiar with one or more alternate methods in the graphical representation of a given function.

We shall illustrate by means of the sine ratio, the wealth of variety which is possible in the picturing of one and the same function.

Text books in Trigonometry invariably confine their graphical treatment of the sine ratio to the "standard" sine curve indicated in Fig. 1.

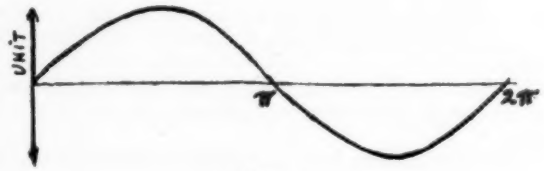


FIG. 1.

It would be well to point out in this connection that we could enjoy the luxury of not merely one but a variety of "standard" sine curves. Any scheme would serve which related the units on the horizontal and vertical scales. For example, the same length of segment which denotes unity in the vertical direction could be used to indicate 90° along the x-axis.

It should be noted, too, that the standardization refers to a fixing of the shape of the sine curve but not its size since the unit segment itself is ordinarily taken as arbitrary.

Since the sine function is by definition the ratio of two line segments the obvious procedure in developing a graphical representation consists in keeping one segment constant thus permitting the changes in the function to be reflected by the variation of the other segment.

Fig. 2 shows that we may select as a constant segment the ordinate or opposite side (a). The latter in turn may be taken as unit length if we so choose. In this graphical scheme we see

that as the angle θ approaches zero the hypotenuse length r increases indefinitely so that the sine ratio (a/r) approaches zero. This representation is perhaps more effective for the reciprocal or cosecant function. If in particular $(a=1$, the lengths r_1, r_2, r_3, etc., picture the cosecant ratio.

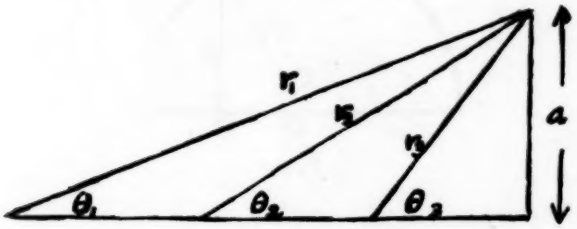


FIG. 2.

The usual procedure is to make the hypotenuse (radius) segment constant. If this value is taken as unity we have a line representation of the sine function which is based upon the so-called unit circle indicated in Fig. 3

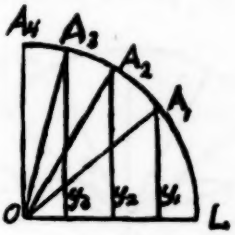


FIG. 3.

Recalling that the sines of the angles LOA_1, LOA_2, etc., are given by y_1/OA_1, y_2/OA_2, etc., and that $OA_1=OA_2=OA_3=1$, we see that the values of the sine function are measured by the ordinates y_1, y_2, etc.*

When a convenient number of the latter are drawn as in Fig. 3, we have essentially a graphical picturization of the sine function. If, in addition, we adopt the convention that the sine graph is the curve formed by joining the end points of these ordinates, we obtain as a "sine curve" the unit circle itself.

* In one sense we are merely deceiving ourselves. When we say that the values of the sine ratio are expressed by the ordinates alone, it is with the understanding that the latter are measured in terms of the radius taken as unit of measure so that the division is still in the background. The point is that we have a divisor (the radius) which is constant.

This amounts to generalizing the concept "curve of a function" to include any curve which correlates the values of a function with those of the independent variable.

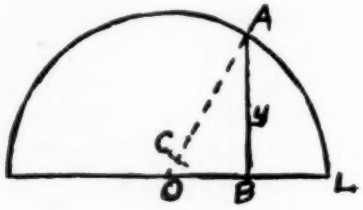


FIG. 4.

We must remember, however, that although every ordinate y (Fig. 4) represents the sine of an angle the latter is pictured not by the horizontal segment OB but by the angle LOA. This "eccentric" difficulty may be eliminated by rotating the ordinate segment AB into the equal segment AC directed along the radius OA.

If this construction is repeated for a number of ordinates y_1, y_2, etc., we obtain the picture presented by Fig. 5.

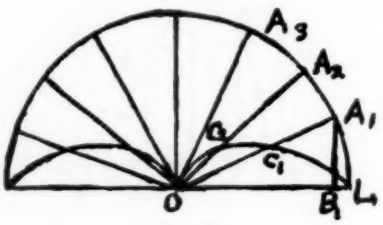


FIG. 5.

The segments A_1C_1, A_2C_2, etc., are simply the ordinate lengths A_1B_1, A_2B_2, etc., swung around and directed along the corresponding radii OA_1, OA_2, etc. The polar equation of the curve traced by the point C is obviously $r = 1 - \sin\theta$. In accordance with the remark made above we shall speak of it as a "sine curve."

The equivalence between arc and central angle invests Fig. 5 with an interesting form of duality. If we adopt the angle point of view, we can imagine the behavior of the sine function to be exhibited to an observer stationed at O and facing in a given direction, say OL, by rotating the entire figure in a clockwise sense. The variation in the segments AC which are suc-

cessively presented to such an observer would produce a vivid picture of the functionality in question.

In dual fashion we can imagine the same observer discovering the values of the sine function by noting the lengths of the segments A_1C_1, A_2C_2, which are successively encountered in traversing the arcs LA_1, LA_2, etc.

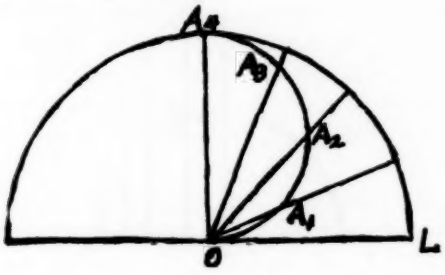


FIG. 6.

From the standpoint of an observer stationed at O an obvious simplification consists in displacing the segments A_1C_1, A_2C_2, (Fig. 5) along their respective radii so that the points C_1, C_2, etc., coincide in O.

Fig. 6 shows that when this is done the curve formed by joining the points A_1, A_2, etc., is a circle whose polar equation is $r = \sin\theta$. Following our convention we may speak of this, too, as a "sine curve."

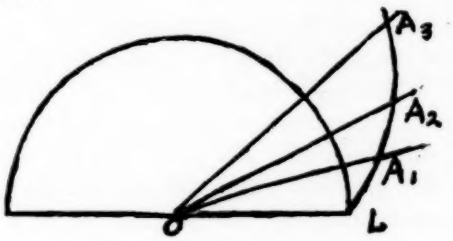


FIG. 7.

An equally obvious simplification in the dual situation, where the observer traverses the arc LA, consists in replacing the curved path by a straight line. When this is done, we have the "standard" sine curve of Fig. 1.

Fig. 7 indicates the "sine curve" which results when the segments AC of Fig. 5 are extended radially outward from the circle.

The equation of the curve described by the variable point A is obviously $r=1+\sin\theta$.

Fig. 8 indicates still another possibility in which the segments AC are swung back to the vertical direction and extended up beyond the circle.

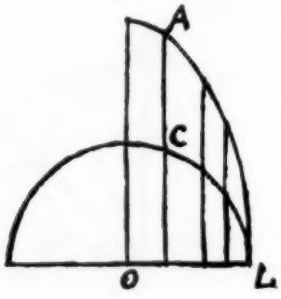


FIG. 8.

Since the coordinates of a variable point A are $x=\cos\theta$, $y=2\sin\theta$, the curve associated with this representation of the sine function is an ellipse, whose rectangular equation is $2x^2+y^2=2$.

Although they are by no means exhaustive, the examples cited are sufficient in number to indicate the very considerable variety in the methods which are available for the picturing of a given function. It seems reasonably certain that a student who has been shown a variety of interconnected graphical representations of one and the same function will gain thereby a clearer grasp of the really simple notions which lie at the back of any graphical scheme. By studying the sine function, e.g., in a setting of equivalent representations, he is enabled to free himself from the subconscious "*idée fixe*" that the "standard" sine curve is the only possible graphical picture. Incidentally with this broader understanding, the student gains a more real, if less worshipful, appreciation of that particular curve.

OCCUPATIONAL INDEX

The 1944 Occupational Index, containing 375 annotated references on 97 military occupations and 441 civilian occupations, is now available in cloth binding at $6.50 from Occupational Index, Inc., New York University, New York 3, N. Y.

Among the new and unusual occupations included are: Aerial Mapping, Archivist, Bibliotherapy, Electronics, Industrial Counseling, Institutional Houseparents, Parasitology, Puppeteer, Readers Adviser, Sword Swallowing, and Whistling.

NOTES FROM A MATHEMATICS CLASSROOM

JOSEPH A. NYBERG
Hyde Park High School, Chicago, Illinois

93. Graphic Solutions of Mixture Problems. Several NOTES have discussed this topic. In October 1943 I pointed out that in many problems where graphic solutions are used, ordinary arithmetic will do a better job and that the graphic work contributes nothing of value. In March 1944 I emphasized that a graphic solution of time-rate-distance problems is of value because the graph shows the state of affairs for *any* value of t whereas the algebraic solution is good for only *one* value of t. The graphic method is decidedly better if one train moves at a certain rate, stops for repairs, proceeds at a different rate, and the other train does likewise at irregular intervals. But I avoid such problems, not because the graph is a broken line, but because some pupil inevitably asks, "Can you do that one by an equation?" If I stop to "do it by an equation" much time is wasted; and if I do not do so, he loses respect for equations as an all-powerful tool. A teacher can not afford to use material that may send the class off on a tangent.

Certainly no one would solve a set of two linear equations by first drawing the graphs. We can justify the graphs only by considering them as preparations for similar more difficult problems. The difficulty is in finding appropriate problems, that is, problems on a ninth grade level that *seem* to the pupil to be practical, regardless of whether they are practical or not. Problems about mixtures appear to meet this requirement. Consider the following:

If a garage has some 20% anti-freeze and some 70% anti-freeze, how many gallons of each should be mixed to make 50 gal. of 30% anti-freeze?

If x and y are the number of gallons respectively of the 20% and of the 70% solutions, then

$$.20x+.70y=.30(50) \quad \text{and} \quad x+y=50.$$

But the first equation can be written

$$.20x+.70y=.30(x+y)$$

which reduces to $y=\frac{1}{4}x$. The class can be led to interpret this equation as meaning that the number of gallons of the 70% solution is always one fourth of the number of gallons of the other

solution, regardless of whether we want 50, 60, or any other number of gallons. And we have thus found something that is useful not only in this problem but in all problems of this type.

The class should next draw the graphs for

$$y=\tfrac{1}{4}x \quad \text{and} \quad x+y=50.$$

On the x axis we have the number of gallons of the 20% solution, and on the y axis the number of gallons of the 70% solution. I assume that the class has previously learned that the graph of $x+y=n$ is a line joining the point $(n, 0)$ to $(0, n)$.

After the graph for $y=\frac{1}{4}x$ has been drawn, we need not actually *draw* the graph of $x+y=50$. We need merely place a ruler so that it passes through the point 50 on the x axis and the point 50 on the y axis, and then notice where the intersection is. The one graph, $y=\frac{1}{4}x$, will solve all the similar problems. Thus, if 40 gallons are wanted, we place the ruler to join the point 40 on one axis and the point 40 on the other axis. If 400 gallons are wanted, and if the x axis not extended that far, we can find the parts needed for 40 gallons and then multiply by 10. Here again the emphasis is on the fact that the graph solves more than one problem.

Suppose next that a 40% solution is wanted instead of a 30% solution. The corresponding equation is

$$.20x+.70y=.40(x+y) \quad \text{or} \quad y=2/3x.$$

And if a 50% solution is wanted, then

$$.20x+.70y=.50(x+y) \quad \text{or} \quad y=3/2x.$$

And for a 60% solution, $y=4x$.

The graphs of $y=\frac{1}{4}x$, $y=\frac{2}{3}x$, $y=\frac{3}{2}$, $y=4x$ may well be drawn on one set of axes. If drawn on the blackboard, the pupils will have an entertaining day proposing problems of this kind, and solving them rapidly by placing the yardstick in the proper position.

I have illustrated the idea with a problem that involves per cents because the garage and anti-freeze seem to be practical matters. Since per cents are always a source of worry, it would be better to have a problem that did not use per cents, but I have failed to find an attractive one. The pupil does not believe that any grocer or confectioner mixes goods worth 50 cents a pound with some worth 30 cents a pound to produce goods of a certain average value. Mixing various grades of cream to pro-

duce cream of a certain per cent of butter fat seems sensible, but these again involve per cents. Problems about separating a sum of money into parts to be invested at different rates can be treated in the same way but, as one pupil said, "Isn't that too important a problem to be solved by graphs? Graphs aren't accurate enough for money problems."

94. Graphic Work with Quadratics. Certainly no one would solve a quadratic equation by drawing its graph. As with linear equations, we must justify the drawing of quadratic graphs by finding problems where the graphic work would be really useful. We can draw the graph of $y=x^2+6x$, for example, and find its intersections with the line $y=k$. Thereby we are using a graph to solve the group of equations $x^2+6x=k$. Here the difficulty is in finding reasonably simple and practical problems that lead to such equations. The best one is:

A garden along a brickwall is to have 80 ft. of fencing. Find the length and width if the area is 400 sq. ft.

The width being x, the area is $x(80-2x)$, and we draw the graph of $y=x(80-2x)$, and then consider the intersections of this curve with $y=400$, 500, 600, and so forth. This work is more suitable for the third semester of algebra, and may there be used to discuss maxima and minima values.

A problem better adapted to the ninth grade is:

Let us suppose we are salesmen for a company that makes cylindric tanks. If d is the inside diameter in inches, and h is the length in feet, then the capacity of the tank in gallons is:

$$G=\frac{1}{231}\times 12\times\frac{1}{4}\pi hd^2$$

or $G=.0408\ hd^2$ which is approximately $G=1/25\ hd^2$. I have purposely chosen d in inches and h in feet in order to arrive at a simple formula.

On one set of axes we may then draw the graphs for various values of h. If four or five such graphs are drawn on the blackboard, the pupils can propose problems like:

What values of h and d can you suggest to a customer who wants a tank with a capacity of 500 gallons? 600 gallons?

Any other formula of the type $z=kxy^2$ can be used for similar work. A good one is $L=kAv^2$ where L is the lift of the wings of an airplane, A is the area of the wings, and v is the speed.

In the third semester of algebra, after the class has proved the theorem about the sum and the product of the roots of a

quadratic, we may show the following graphic method of finding the roots.

Write the equation in the form $x^2+px+q=0$.

Let A be the point $(0, 1)$, and B the point $(-p, q)$.

Draw the circle whose diameter is the line AB.

Then the intersections of the circle with the x axis are the desired roots.

This work leads to the solution of a single equation, not of a group of equations. But the proof of the method involves some good review of geometry, which is often desired in the third semester of algebra.

Let C and D be the intersections of the circle with the x axis. If O is the origin, then $OC+OD$ is the sum of the roots and we must prove that $OC+OD=-p$. This involves an exercise that is proved in almost every geometry class.

Also, $OC\times OD$ is the product of the roots and must be proved equal to q. If H is the second point of intersection of the circle and the y axis, then $OC\times OD=OA\times OH$. But $OA=1$, and OH can be proved equal to q.

The method is applicable whether p or q are positive or negative, care being taken to plot B correctly.

The method points out another value of graphs; namely, we can use it to study the changes in the roots as the numbers p and q vary. By changing p and q the circle can be made to touch the x axis, giving two equal roots, or fails to intersect the axis, showing complex roots. An interesting problem for the bright pupil is that of showing that the circle is tangent to the x axis if $p^2=4q$.

JOBS FOR BLIND TYPISTS

A blind typist is employed in the X-ray department of one of the base hospitals of the Department of Health for Scotland, according to a report carried in the British Medical Journal. Her job is to transcribe the remarks of the radiologist as, in total darkness, he screens successive patients. This relieves him of the necessity of relying on his memory or on his notes scribbled after each examination.

PORTABLE STERILIZER FOR THE SICK-ROOM

Portable sterilizer to purify air in a sick-room is a bowl-shaped receptacle opening upward, containing an electric motor, fan and several germicidal lamps. The air, driven between the lamps, is sterilized by ultraviolet rays. It may be mounted in the ordinary inverted-type floor lamp.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

BOARD OF DIRECTORS MEETINGS

Report of secretary, HAROLD H. METCALF

The meeting of the Board of Directors was called to order by president Emil Massey at 7:30 P.M. on Friday, November 24, 1944. Those present were vice-president George E. Hawkins, secretary Harold H. Metcalf, treasurer R. C. Soliday and directors Joseph E. Dickman, Milton D. Oestreicher, Paul E. Kambly, H. C. Christofferson, Geraldine Reep Johnson, John Mayfield, J. T. Johnson, R. E. Park, Arthur O. Baker, Walter H. Carnahan, Ruth W. Mikesell, Paul L. Trump, and George K. Peterson.

Mr. Massey stated that he carried out the directions of the Board of Directors as closely as possible in planning the convention and had very fine cooperation from every one concerned with putting on the meeting. He pointed out that it is becoming increasingly difficult to get enough rooms of proper size to house the various sections and that this year the conference on post war civil aviation continued through November 26th and caused the hotel to give some of our facilities to them. With our country at war, inconveniences and last minute changes in arrangements must be considered unavoidable. Mr. Massey was called to Washington by Commissioner of Education, Studebaker, to become a part of a small group discussing plans for science teaching in the post war period. A report of the outcomes of this conference is available to those who will write to Mr. Massey.

Mr. Hawkins, chairman of the journal committee, called on Mr. Soliday to give the financial status of the journal, SCHOOL SCIENCE AND MATHEMATICS. Mr. Soliday discussed the audit of the last fiscal year of business which showed the following highlights: Fiscal year July 1, 1943–June 30, 1944. The accounts of the Association and of the Journal were consolidated into one account. Total income $10,104.03; total expenditures $9,722.22; net income from operations $381.81. This was an increase in net income of $611.71 over the fiscal year 1942–43. The assets of the association as of June 30, 1944 were $9,960.20 of which $3,342.29 was in cash and $148.00 in gov't bonds. On November 30, 1944, the cash balance was $5,336.46.

Mr. Warner was then called upon to discuss the editorial aspects of the journal The journal now comes out on the fifteenth of the month preceding the printed date. This makes it possible for the teachers to receive the June issue before schools close. The papers on hand and the papers received from speakers at the convention will fill approximately three issues. Mr. Warner asked that the members of the board assist in encouraging people who are doing significant things in the fields of science and mathematics to submit articles for publication.

Mr. Park moved, Mr. Peterson seconded and it was carried that the reports of the business manager, editor, and journal committee be accepted.

Mr. Hawkins moved, Mr. Christofferson seconded and it was carried that Insurance of $2,000 be carried on past issues which are kept on hand in the Soliday household.

Mr. Hawkins moved, Mr. Trump seconded and it was carried that the salary paid to the business manager and the editor, who at present are Mr. R. C. Soliday and Mr. Glen W. Warner, be raised from $900 to $1,050 annually respectively, to start Jan. 1, 1945.

Miss Charlotte Grant, in the absence of Mr. Porter, chairman, read the report of the resolutions committee. Some discussion followed and parts

were deleted. The final report which was accepted in the Saturday morning business session appears in a later portion of the minutes.

Mr. Urbancek, chairman of the place of meeting committee gave an extensive report on the study he and his committee made of the problem. Both a questionnaire returned to Mr. Urbancek by 61 members living in six different areas served by the association and the votes of the members of the committee were very much in favor of Chicago. The uncertainty of the duration of the war is a big factor in members' thinking. The committee recommended Chicago for the 1945 convention.

Mr. Christofferson moved, Mr. Johnson seconded and it was carried that Chicago be the 1945 convention city.

The policy of meeting two years in Chicago and one out in each three year period is being temporarily discontinued because of the war emergency.

Some discussion ensued. Mr. Potzger stated that Chicago conventions made yearbook advertising sell better; Mr. Urbancek criticized the treatment received at the hotel but moderated his statement somewhat in light of the difficult situation which the hotel had to face. Mr. Dickman proposed that speakers and section chairmen be responsible for providing projectors from now on at conventions.

Mr. Dickman moved, Mr. Christofferson seconded and it was passed that a committee be appointed by the incoming president to study the section and group divisions of the association with view toward simplification but to consider the inclusion of sections in preflight aeronautics and economic statistics. The report is to be brought back to next year's convention.

Mr. Christofferson moved, Mr. Johnson seconded, and it was passed that the report of the resolutions committee as amended in thought by the place of meeting report and the motion to study the sections and groups of the association be accepted.

The resolutions committee report, as accepted, follows:

1. Whereas the present war period necessitates greater cooperation and, integration in the fields of science and mathematics, and whereas the meetings of the Central Association of Science and Mathematics Teachers offer opportunities for such cooperation and integration be it hereby resolved that we recommend the holding of a convention in 1945.

2. Whereas the high school population is undergoing rapid change from the college preparatory group to a life preparatory group, and whereas the present high school curriculum is not adequately meeting the change—be it hereby resolved that the association go on record favoring a decrease in emphasis on the college preparatory curriculum.

3. Whereas, the war is bringing great technical, scientific, and educational changes—be it hereby resolved that the convention program next year give further thoughtful consideration to science and mathematics in the post war era.

4. Whereas, the planning and execution of plans during a period of crisis is extremely difficult and uncertain—be it hereby resolved, that we extend to those in charge of this year's convention our thanks and appreciation for a highly successful program of activities.

Submitted by the Resolutions Committee,
Acting chairman, Charlotte Grant.

Mr. Leonhard, chairman of the membership committee, thanked Mrs. Johnson, the former chairman, for her help and suggestions in planning the work of the committee. Out of this year's experience, Mr. Leonhard made the following suggestions:

1. To ease the work of the chairman and to improve his value to rest of the committee, keep membership files and publish the yearbook lists by States.
2. A more liberal budget allowance for the work of the committee because through the work of the committee the organization grows.
3. Set all deadlines for yearbook material ahead at least two weeks.
4. The board consider the guest problem in light of the registration of 367 members and 316 guests. Guests pay 50 cents.
5. That the membership chairman be notified of future directors' meetings that he may make recommendations from time to time.
6. That at least four typewriters and typists be available for each convention.
7. That thought be given to a type of convention badge other than the form now used.

Mr. Peterson moved, Mrs. Mikesell seconded and it was passed that the report of Mr. Leonhard be accepted.

Mr. Leonard, chairman of the journal display committee, reported and made the following suggestions:

1. The type of display be changed. People are not interested in old convention programs and magazines.
2. That space be planned for and provided. If the display were housed in a room in which people could relax and be comfortable, it would attract more attention.
3. Several reprints were sold. Most reprints are more than a year old. New titles should be provided.
4. A badge of a different form from the one now used be provided for members.
5. A little more bally-hoo for the journal display, better space, at least one menber of the board of directors at the exhibit all of the time, and a map or globe showing the location of subscribers will all help.

Mr. Trump moved the acceptance of the report, Mr. Oestreicher seconded and it was passed.

Mr. Schwachtgen, chairman of the local arrangements committee, reported that "service with satisfaction" was the slogan of his group. He paid special tribute to the luncheon committee. He also spoke highly of the efforts of other members of his committee.

Mr. Oestreicher moved the acceptance of the report with thanks for a job well done, Mr. Peterson seconded, and it was passed.

Mr. Potzger, manager of the yearbook, reported that the cover was designed by Miss Whitney to show the contributions of science and mathematics to victory. This was the largest yearbook in history, 88 pages excluding covers. This year 5,000 were printed and many left. Next year, a plan should be developed for greater use or only 4,000 should be printed. The company which did the printing was commended for the job done; Benton Review Publishing Company of Fowler, Indiana. Two high school boys were employed for two nights as watchmen at a cost of $4 each per night. In spite of the charge of $35 per page with booth privilege, advertising was easier to sell than it had ever been. $5 per table was paid to the hotel and the highest profit ever was returned to the association, at least $360.63.

Mrs. Johnson moved the acceptance of the report with thanks, Mr. Dickman seconded and it was passed.

Mr. Hawkins previously paid tribute to the work of Mr. Soliday, Mr. Warner and Mr. Potzger. He stated that Mr. Potzger had written to him a letter of resignation from the yearbook managership prompted by increased responsibilities at Butler University. Mr. Hawkins stated that

the journal committee was convinced that it would be unfair to Mr. Potzger to urge him to stay on in the job. The members of the Board of Directors all expressed regret.

Mr. Peterson initiated a discussion pertaining to individual and group mailing of yearbooks. The 400 sent to Mr. Dickman were distributed to the grade schools in Chicago. Mr. Potzger said that he was sending the books to individuals at a cost of two cents each.

Mr. Soliday stated that next year the publisher of the magazine would run the envelopes for yearbooks through the addressograph.

Mr. Warner gave the necrology report. Since our meeting last year, the death of the following members of the association occurred: C. E. Spicer, M. J. W. Philips, Charles A. Stone, John Hessler, A. C. Field, David Eugene Smith, and Elliott R. Downing.

Mr. Massey called on the members of the board to stand with bowed heads in silent tribute to the men who were held in high esteem by the members of our association.

Mr. Metcalf read a letter of appreciation from Mrs. W. F. Roecker for the tribute paid by the association to the work done by Mr. and Mrs. Roecker for the Central Association of Science and Mathematics Teachers.

Mr. Massey proposed a project for commemoration of fifty years of service by the Central Association. The board directed Mr. Peterson and Mr. Baker to bring in a proposal when the board reconvened on Saturday.

The meeting was adjourned.

Board of Directors Meeting, Saturday, November 25, 1944.

The Board of Directors meeting was called to order by President Massey at 2:15 P.M. on Saturday, November 25, 1944. All members were present.

Mr. Peterson moved, Mr. Park seconded and it was passed that: a committee consisting of Mr. Massey as chairman and Mr. Schreiber be appointed to consider the problem of arranging the celebration of the 50th anniversary of the Central Association of Science and Mathematics Teachers and to submit a report to the Board of Directors at its spring meeting. The report should include (a) plans for expanding the committee and (b) a statement of further details related to the conduct of the project.

Mr. Baker moved, Mr. Trump seconded and it was passed that: President Massey be complimented on the fine job he has done in planning and in carrying out the 1944 convention.

Mr. Hawkins moved, Mr. Christofferson seconded and it was passed that: the bills submitted by the membership committee be paid.

Mr. Potzger moved, Mr. Christofferson seconded and it was passed that: the expenses incurred by the historian be paid by the Association. A bill should be submitted at the fall meeting.

Mr. Christofferson moved, Mr. Kambly seconded and it was carried that: the resolution on the metric system as it appeared in the November issue of SCHOOL SCIENCE AND MATHEMATICS and as it was submitted by its sponsor, J. T. Johnson, be adopted.

The meeting was adjourned and the outgoing members of the board retired.

Mr. Walter H. Carnahan, the newly elected president for 1944–45, took the chair. The newly elected members of the Board of Directors were present. They are as follows: George E. Hawkins, Lyons Township High School and Junior College, LaGrange, Illinois; J. E. Potzger, Butler University, Indianapolis, Indiana; Mary A. Potter, Board of Education, Racine, Wisconsin; Charlotte L. Grant, Oak Park and River Forest Township High School, Oak Park, Illinois; and Fred D. Leonhard, Mackenzie High School, Detroit, Michigan.

President Carnahan nominated Mr. Massey and Mr. Baker to be members of the new executive committee with him.

Mr. Trump moved, Mrs. Johnson seconded and it was passed that the recommendation of Mr. Carnahan be adopted.

President Carnahan suggested a change in the wording of the resolution relating to the 1945 convention theme to "Planning for a world of peace."

Mr. Dickman moved, Mr. Park seconded and it was passed that the names on the letter heads of the Association be dispensed with. Only the official name of the Association is to appear.

Mr. Mayfield suggested that the secretary mimeograph a list of all Association officers and send it to all officers. This is to be in addition to the appearance of the names in the Journal.

The cost of the appearance of Mr. Bromfield on the Association program is to be the buying of five memberships in Friends of the Land at five dollars each.

President Carnahan appointed Miss Grant the chairman of a committee to decide on the use to be made of the five memberships each of which carries a year's subscription to their magazine.

The responsibility for appointing a successor to Mr. Potzger as manager of the yearbook was left to the Journal Committee.

Mr. Carnahan urged a full attendance at the spring Board meeting, the date of which will be chosen on the basis of information to be gathered.

The meeting was adjourned.

ANNUAL BUSINESS MEETING
NOVEMBER 25, 1944

President Massey called on Miss Grant for the report of the Resolutions Committee which is printed in the official minutes.

Mr. Trump suggested that section 2 give positive emphasis to preparation for life rather than negative emphasis to preparation for college. Mr. Potzger concurred.

Mr. Agren moved adoption, Mr. Davis seconded and it was carried.

Mr. Leonhard gave the Membership Committee report. He stated that 683 registered, 316 as guests and 367 members. A further report of the committee is printed in the official minutes.

Mr. Christofferson moved, Mr. Trump seconded and it was carried that the report be accepted.

Mr. Warner gave the Necrology Committee report and Mr. Potzger gave the Yearbook report. Statements of these reports appear in the official minutes.

Mr. Read moved the adoption of the reports, Mr. Bower seconded and it was carried.

Mr. Agren, in Mr. Urbancek's absence, gave the Place of Meeting Committee report. He reviewed the thinking that led the committee to recommend Chicago for the 1945 convention. Mr. Read objected to the facilities provided by the hotel for the section meetings saying that many were turned away.

Mr. Potzger moved that Chicago be the convention city for 1945, the motion was seconded and carried.

In the absence of Mr. Neal, Mr. Peterson gave the report of the Nominating Committee. The officers nominated are as follows:

President, Walter H. Carnahan, Purdue University; Vice president,

Joseph E. Dickman, Board of Education, Chicago; Board of Directors, two year term, George E. Hawkins, Lyons Township H. S. and Jr. College, LaGrange, Illinois; Board of Directors, three year terms, Charlotte Grant, Oak Park, River Forest Twp. H. S., Oak Park, Ill.; Fred D. Leonhard, Mackenzie High School, Detroit, Michigan; Mary A. Potter, Board of Education, Racine, Wisconsin; J. G. Potzger, Butler University, Indianapolis, Indiana.

Mr. Davis moved that the report of the committee be accepted and that a unanimous ballot be cast for the nominees, Mr. Christofferson seconded, and it was carried.

Miss Royt suggested that each of the standing committees of the Association be provided with a book of instructions on tradition and procedure; that the membership blank used for registration be large enough so that the information provided on it can be easily read and the information needed can be easily written in; that the Association publication, SCHOOL SCIENCE AND MATHEMATICS, be advertised in the Friday general session; and that the Membership Committee should always have at least one representative from each state in which the Association is active.

Mr. Trump moved adjournment, Mr. Gingery seconded, and it was carried.

In the general session which followed, Mr. J. T. Johnson read a paper on "The Status of the Metric Movement." He presented to the audience the resolution which was printed in the November, 1944 issue of SCHOOL SCIENCE AND MATHEMATICS. Mr. Hawkins, chairman of the session, called for action; J. T. Johnson moved acceptance of the resolution, Ray Agren seconded and it was carried by a vote of 56 to 0.

GENERAL SESSIONS AND FRIDAY LUNCHEON

The general meetings and the luncheon were of a very high caliber. All of the papers will appear in forthcoming numbers of the journal, SCHOOL SCIENCE AND MATHEMATICS. Mr. Ripley gave an informative, witty presentation, including much illustrative material that had come off the production lines of General Electric company which proved the contribution of science and industry to Power for War.

BIOLOGY SECTION

Presiding: Mr. A. L. Smith

The first speaker of the afternoon was Rev. George M. Link, formerly of the Illinois State Park system. Reverend Link discussed the use of nature trails in teaching nature appreciation so that people can visit their parks and be happy without radios, ball diamonds and golf links. These latter have their use in nature parks also, but they should not be the primary.

Nature trails should be circular and not over a half mile in length. They may mark three factors in the landscape: the rock formations and soil under foot, the plans in the surroundings and the animals. Markers may be in different colors, as for instance brown for the soil, green for the vegetation and red for the animal life. Red, white and blue markers may be used to point out things of local historical value. They should not be too large and consist of not more than twenty words. If more markers are needed they may be mounted in a vertical series. Language of the markers should be exciting and picturesque. Education can be a religious experience and particularly nature study. Rev. Link closed his address with the quotation "And Cain went out from the Lord and builded a city." Closer communion with nature a powerful factor in character building.

The nominating committee, Miss Cecelia Lauby, Thornton Twp. High

School, Harvey Illinois, Mr. Ralph Beck, Goshen High School, and Mr. A. G. Rosche, Waukegan High School, reported on the officers for the next year. Elected were Mr. Ross Aeby, Oak Park-River Forest Twp. High School, Oak Park, Illinois, chairman; Miss Ethel Schierbaum, Harper High School, Chicago, vice-chairman; Mr. Fred J. Burdine, Thornton Twp. High School, Harvey, Secretary.

Dr. John C. Sylvester from Abbott Laboratory was the next speaker. His subject was the preparation of the drug penicillin. Penicillin comes from a green mold related to the ordinary mold found on old oranges and is known as *Penicillium notatum*. The parent plant from which all cultures are made lives in a test tube that is kept in refrigeration. From this parent a spore bearing plant is grown in a special culture of bran and ground corn. The spore bearing plant produces little penicillin and is used only for propagation purposes. It is transplanted to a special culture arranged in pans one inch deep. Here it is allowed to incubate at a fixed temperature from six to eight days. It develops a thick white scum that wrinkles and has a velvety appearance. In the broth the penicillin has been forming as the mold grows. At the time of harvest the broth is drained off, the scum is left behind. Another method of growing the mold is to stir it into a 20,000 gallon vat of broth. If the vat method is used the period of incubation is two days. In that time the broth becomes mush like. Penicillin has been secreted into the broth as the mold grows. Again the broth is separated from the plant and is used. The broth is mixed with an organic solvent in an acid medium. Penicillin leaves the water and goes into the organic solvent. Now the solvent containing penicillin is removed, placed in water and neutralized. In the neutral medium the penicillin leaves the solvent and passes into the water. This process is repeated several times. It has the double purpose of concentrating the drug and at the same time purifying it. It is now put into a sodium hydroxide solution, frozen and dehydrated in a vacuum drier. It must be stored in the dry condition as it is very unstable in a liquid form.

Dr. Jonathan Forman, editor of the Ohio State Medical Journal was the next speaker. His subject was Conservation. Dr. Forman spoke on the history of conservation in the United States and the greatly increased activity during the past ten years. Our conservation problem is how to make use of our resources to get a strong healthy people living in an efficient social order. There are many conservation organizations in our society. The ornithologist conserves bird life; the forester, the trees; the hunter and fisherman are interested in restoring our wild life; the farmer in all sorts of soil conservation; the engineer, in flood control, navigation and hydraulic power. The latest resource that needs study is the water table. It has fallen in some parts of Ohio at the rate of a foot a year in the past twenty-five years. In its broad aspects conservation is an effort to keep nature in balance and to give every species its place in the sun. This includes even the bees, bacteria and worms. Nature is the greatest physician and can contribute much to rehabilitation of the sick and injured. Hence conservation also includes caring for parks and playgrounds. As we use up our mineral and oil resources we shall depend more and more on those resources that are replacable to substitute for them. Chemurgy is the science that takes aluminum out of clay, changes curds to wool and makes plastics out of wood. But clay, curds and wool all come from the land. Land then is the ultimate resource of any nation. We must conserve our land. Dr. Forman left the following conclusions with us:

1. Conservation must be undertaken by the entire people.
2. Talk conservation among your friends; live it on your property.
3. Learn the literature in this field.

4. Spend summer vacations in a conservation camp.
5. Lead youth into greater harmony with nature.

I believe it was Dr. Forman who supplied Rev. Link with his concluding quotation.

ETHEL SCHIERBAUM, *Secretary*

CHEMISTRY SECTION

E. G. Pierce discussed the Training of Chemists at East Technical High School in Cleveland. The war has increased the demand for junior chemists in industry and there have been many problems to be met in teaching high school boys who "think" they know something of analytical chemistry. The talk was well illustrated by a colored motion picture.

T. A. Ashford presented a paper on Chemistry in the Testing Program of the United States Armed Forces Institute.

Dr. Gustav Egloff gave an inspiring address on the Impact of Chemistry on the Oil Industry. It will appear in a later issue of the Journal.

WALTER GEISLER, *Secretary*

ELEMENTARY SCIENCE SECTION

The Annual meeting of the Elementary Science Section of the Central Association was called to order Friday Nov. 24, 1944 at 2:30 o'clock by Miss Hazel Sequin, Chairman. The minutes of the last meeting were read and approved. A nominating committee composed of Dr. Paul Kamble, Miss Elizabeth Davies and Illa Podendorf was appointed by Miss Sequin, Chairman.

The program opened with a most interesting demonstration conducted by Dr. Mary Eliff, formerly of Ethical Culture School, New York City, and at present an editor for Scott, Foresman & Co. Pupils of the first and second grade room from North Evanston School, Evanston, Ill. took part in the demonstration. Examples of various weather conditions found in Pictures in "Look and Learn" by Beauchamp, Crampton, and Gray led the pupils to see relationships and helps them to organize thinking.

Miss Olga Adams, Director of Senior Kindergarten, University Laboratory School, University of Chicago, gave a most inspiring and educational talk. Theme—"Development of Readiness for Science in Young Children." She stressed the important phases of readiness

1. The building of readiness, the responsibility of the class room teacher.
2. Readiness in its practical out-of-school meaning.
3. Readiness in our every day interpretation involves actual contacts, need or use of these experiences, enthusiasm to know more.
4. How the class room teacher of young children and science teachers work together.

Mrs. May Theilgaard Watts, Naturalist, The Morton Arboretum, Lisle, Ill. "Games & Stories in Nature Teaching."

She stressed the many interesting ways by which science learnings can be remembered through use of games, stories, and songs. The audience took part in playing many of these games. Mrs. Watts related several very good books that she knew would be very helpful to the classroom teacher. The meeting was a very profitable one for all that attended.

HILDEGARD C. PIEPER, *Secretary*

GENERAL SCIENCE SECTION

"A More Courageous Social Hygiene Program" was discussed by Aimee Zillmer of the Wisconsin State Board of Health. In a program laid out on

paper, the social hygeine program for normal living is four fold: legislation, medication, protection, and education. The speaker is engaged in the fourth area, education. She asked, "Is it necessary to wait for war to take up the matter of sex education?" The speaker does not propose how to do the job of educating. Rather, she believes that, war or no war, prophylaxis and contraceptives are a last minute substitute for sound education. Youngsters deserve some preparation for the life they are to lead in the army or as a civilian. Ideals should be established through a proper, informative, class room approach to the problem.

"Blood in Reserve," a technical film showing preparation of human blood plasma was shown through the courtesy of the Cutter Laboratories, Berkeley, California. A detailed account of the technique employed will appear in the journal.

THE GEOGRAPHY SECTION

The Geography Section of the Central Association of Science and Mathematics Teachers met at 2:30 on Friday afternoon at the Stevens Hotel, Miss Monica Kusch, Chicago, presiding. Other officers present were Miss Villa B. Smith, Vice Chairman, Cleveland, Ohio; and Miss Emilie Huck, Secretary, Centralia, Illinois.

The nominating committee, Ruth Mikesell, Chairman, Laura Walkers, Floy Hurlbutt, members, submitted the following names for officers for the ensuing year: Villa B. Smith, Cleveland, Chairman; William Gregory, Cleveland, Vice Chairman; Lucille Kenney, Lakewood, Ohio, Secretary. The report was accepted and officers declared elected.

The first speaker for the afternoon was Miss Edith P. Parker, Associate Professor of Geography, University of Chicago, who stressed the importance of global geography and the shrinking world—two factors making isolationism impossible. She made it clear that one must not merely know facts, but that one must know the results and interrelationships of these facts; in other words, "What of these facts?" As an example, Miss Parker pointed out that because of Great Britain's far-flung empire, she not only controlled the seas, but is now in a position to control the airways also. "What of it?" How will this affect the future security of the world?

The second speaker, Mr. William Gregory, Western Reserve University, Cleveland, Ohio, discussed visual materials for the teaching of geography, emphasizing the variety and abundance of visual aids and how they can be used in the classrooms.

Miss Lucille Kenney, Director of Visual Aids, Lakewood, Ohio, gave a demonstration lesson using visual aids to gain information. She used as her demonstrator, a moving picture depicting life on a farm in the corn belt. (The school group was supplied by the Chicago Heights school system, Ben A. Sylla, Superintendent.)

An excellent exhibit of Latin American materials was on display in the conference room.

The journal will carry manuscripts of the papers delivered.

EMILIE HUCK, *Secretary*

MATHEMATICS SECTION

Mr. E. G. Hexter, chairman, called the meeting to order at 3 P.M., November 24, 1944 in the Conference Room of the Hotel Stevens. Also present were Miss Mildred Taylor, vice-chairman, and Mr. G. A. Waldorf, secretary.

The first address "Mathematics for All and a Double Track Plan of Curriculum" was presented by Dr. Harl R. Douglass, Director, College of Education, University of Colorado, Boulder, Colorado. Dr. Douglass

spoke with authority on this subject, having taken a mathematics major in college, and having had experience as a teacher and as a writer of textbooks in this field. He stated that everyone should take two years of mathematics in high school, and that some students should take more than this minimum. This mathematics however should not necessarily be the kind which we have been teaching. The needs of all students cannot be met with a single program. The armed forces are worried because the rank and file of inductees cannot work simple arithmetic, and have no knowledge of the elements of simple algebra or geometry. Dr. Douglass believes that all the needed arithmetic cannot be taught in the grade schools and that it is important that it also be taught in the high schools.

The "Double Track Plan," presented by Dr. Douglass, consisted of two possible paths along each of the two requisite tracks. Track I is to be followed by that great mass of students who are not mentally equipped for rigorous mathematical study. Plan I suggests that in each year of school beyond the 8th grade the student should take alternate semesters of related mathematics and science. Plan II calls for two years of general mathematics in the 9th and 10th grades or later. This general course would not contain much of the material of commercial arithmetic or other specialized courses, but rather a lot of arithmetic, the idea of the equation and function from algebra, little or no use of formal proof but a great deal of application and construction from geometry, the elements of simple trigonometry, ratio and proportion, and great emphasis on approximate numbers and mental arithmetic. He believes that we should not give a sugar-coated course in traditional algebra in lieu of one of the above mentioned plans. Track II is for those students to whom we might refer as mathematics specialists. This is the group which can profit by strenuous treatment of the subject. Plan I calls for the old-fashioned sequence,—1st. year Algebra, 2nd. year geometry, 3rd. year algebra and trigonometry, 4th. year arithmetic, algebra, and solid geometry. Plan II, which Dr. Douglass considered better, called for general mathematics in the 9th. grade, algebra, in the 10th. plane and solid geometry combined in the 11th., and a combination of arithmetic, algebra, and trigonometry in the 12th. year.

Dr. Douglass stressed the fact that the next few years are critical ones for science and mathematics. He stated that there is a strong movement in our favor now but not for the kind of mathematics and science we have been teaching. There are new type text books coming out soon. We, as teachers, must have the courage and stamina to try out these new courses. Dr. Douglass stresses the point that we must be able to get along without a war every few years to revive interest in our subject.

Dr. E. H. C. Hildebrandt, Assistant Professor of Mathematics, Northwestern University, Evanston, Illinois, began his interesting discourse on "Multi-sensory Aids and Post War Mathematics Teaching" by calling our attention to a walnut. He likened our text books, forms, and figures of mathematics to the shell of the nut. Inside the shell of the nut is the kernel where life exists. In mathematics there is also an inner kernel but all too many students never reach it.

Dr. Hildebrandt asserted that if mathematics is to be called the queen of the sciences, we should treat it as such and equip our classrooms with laboratory materials, so that we can teach through the various senses. He cited the statement of the ancient educational reformer, Comenius—"What is not in the senses is not in the mind." He then used concrete objects to illustrate the type of thing which can be done at the various grade levels, e.g.—At the elementary level, in learning to count and comprehend the concept of area and volume, blocks of various kinds can be

used. The student then reads about, sees, and feels, area and volume. At the junior high school level, scale drawings, use of solids, and paper folding are indicative of some possible devices. In plane geometry many figures showing the locus concept by motion and variation can be constructed. Solid geometry can be vitalized by use of cubes, cutting cubes to form other figures, soap film models, rotating cubes, tinker-toy models, etc. We have missed many opportunities afforded by the slide-rule and the black-board sphere in plane and spherical trigonometry.

Dr. Hildebrandt stressed the fact that we are to have the proper sensory materials at hand at exactly the proper moment in order to get at the desired mathematical "kernel." He believes that mathematics classrooms should be equipped with models, instruments, filing cabinets, projectors, colored slides, film strips, opaque projectors, and a multitude of other materials in order to achieve this ideal. The use of these materials is also a means of speeding up the mathematics courses according to present day needs.

The address was closed with the assertion by Dr. Hildebrandt that the pathway of mathematics instruction which we now adopt will be followed for the next twenty years and that if we choose the pathway of multisensory aids, our students will be able to get at the real "kernel" of mathematics.

The report of the nominating committee, consisting of Dr. Wm. Krathwohl, Chicago, Mr. Jos. J. Urbansek, Chicago, and Miss Martha Hildebrandt, Maywood, Illinois, was presented by Dr. Krathwohl. He reported that, when interest warranted, the officers of the section were advanced along the line. However, since Mr. Waldorf had been permanently shifted from mathematics teaching to physics, he had asked to be excused. The following slate was then presented and elected, Chairman, Miss Mildred Taylor, Fenger High School, Chicago, Illinois; Vice-Chairman, Dr. J. M. Kinney, Wilson Junior College, Chicago, Illinois; Secretary, Mr. H. Vernon Price, University High School, Iowa City, Iowa.

G. A. WALDORF, *Secretary*

PHYSICS SECTION

Chairman C. W. Jarvis called the physics meeting to order and introduced W. W. Davies, research engineer with the United Air Lines, who presented his illustrated discussion of Aircraft Instrumentation.

The nominating committee made its report and the following officers were elected: W. N. Smith of Technical High School in Cleveland, Chairman; E. G. Plasterer of the Huntington Indiana High School, vice chairman; and Antone Geisert of Von Steuben High School of Chicago, secretary.

A motion was passed to form a committee to study text books and manuals to determine which materials or subject matter should be eliminated or revised in what seems to be an over crowded physics course. A report is to be returned at the next annual meeting. Part of the committee is as follows: P. A. Tapley, chairman, Harper H. S., Chicago, Ill.; J. H. McClelland, Harrison H. S., Chicago; and R. W. Lefler, Purdue University.

"Electronics in War and Post War Applications" was the title of a well prepared paper by T. E. Johntz, Application Engineer of the General Electric Company. Electronics in the transmission of power, in the control of power, and in the production of power was well illustrated by a series of slides. The precision of electronics in the control of many involved industrial operations bearing directly on the war effort was demonstrated. One striking use of electronics is in the rectification of current used in the aluminum industry.

Watson Davis, director of Science Service, Washington, D. C. talked on the Place of Science and Mathematics in Post War Secondary Education. He also discussed the roll Science Clubs and Junior Academies would play.

E. G. PLASTERER, *Secretary*

ELEMENTARY SCHOOL GROUP

The Elementary School Group presided by Kathryn Steinmetz had one of the outstanding programs of the convention. Dr. Don Rogers, Assistant Superintendent in charge of Elementary Schools of Chicago, showed a sound film recently produced by him for the purpose of improving the use of the film as a teaching aid. He maintained that films cannot supplant the teacher, but should be used where other methods fail. Films can expand and enrich the activities of the pupil. There are eleven things which a film, if properly used, can do better than the abstract learning in the book, such as: the transferring of the pupil to different places in the world with the speed of light in comparing life in different places of the globe; the transferring of time backwards in comparing life as he knows it with the past; the concepts which can be illustrated by diagrammatic motion which involves changes as the motion continues; the development and changes that take place slowly and require experts to maintain as in living things; the experiences that only few can observe as eclipses of the sun and other telescopic photography as in bird studies; the slow motion analysis in athletics or stopping motion at any point for analysis; the under-water photography that gives interpretation to life habits of living things; the bird's-eye view of aerial photography which is the only way the topography concepts of his environment can be given; the bringing of inaccessible materials to the classroom such as a coal mine; the concepts of growth and change in living things that cannot be speeded up naturally can be speeded up by time-lapse photography to illustrate a principle; or the life cycle of any living thing which may take a full season or years to complete. He emphasized the basic rules which we should abide by so as not to "risk discrediting films—and ourselves" in teaching, namely: 1) Select films with care, 2) Prepare—before showing film, 3) Restrict showing film to one group, 4) Show only one film at a sitting, 5) Show film at least twice, 6) Not use school room for entertainment films, and 7) Avoid advertising and propaganda films.

Dr. Robert J. Havighurst laid out before us one of the largest and most challenging problems. How are we going to fight our next "war"? We have enemies in society which we must fight. The seven "enemies" which were brought to our attention were: disease, accident, waste, ugliness and dirt, delinquency and crime, unemployment, and hatred and intolerance. He said that the method of science must permeate all of the thinking and that changes in society can only be accomplished through our work with the very young child. The science teacher must build up a basic attitude at the lowest grade level. We must capitalize on the willingness of a child to take things from his teacher. He is more permeable to the teacher at a lower level. It is our duty to see that some form of the National Defense Research Council continues to function after the war in order to fight this next "war" of ours. We must have some national appropriation to fight these enemies of society. It probably is necessary to link hands with the social studies teacher in order to conquer these "enemies," but in order to do this scientific method and scientific knowledge of the individual and society is necessary.

Dr. Walter Wittich of Wisconsin gave an impromptu demonstration Lesson on The More Effective Classroom Use of the Text Film in Ele-

mentary Science. He gave a very concrete idea of one approach to the study of a film. Emphasis was again given that there are certain concepts a teacher cannot give and that the best teacher has to resort to mechanical means to accomplish these. The film recreates the experiences. It cannot reproduce them. In order to teach effectively with films the child must have an interest or desire to know. It is necessary for the teacher to arouse his curiosity. The child must be challenged. The teacher must remove the barrier or the barriers must be reduced to such a size that the child can surmount them. To challenge him the child must have certain responsibilities and these responsibilities must be set within his limits. In developing the work of the group in the demonstration Dr. Wittich had pupils compare the concept he was developing with those that the child was familiar with. He used elements of imagination, explanation, estimation in laying the ground work or story. The things which the group was going to look for in the film were carefully developed in terms of the child's own vocabulary and knowledge level. Indeed it was necessary that the child understand the words he was going to hear in terms of what they could understand. By using a Learning Guide, it was clearly shown that much more interest can be developed and consequently much more understanding can take place and with much less difficulty for the child to follow. The test questions were gone over and checked to determine those things they did not know. It was the child who solved the problem on how they could find out the things they did not know. Thus, it became a problem set up by himself and therefore was more interesting. Further activities and extended reading should result in more reading, more understanding, better reading, better comprehension because of a better mental picture and a better attitude toward what he is reading. Films must be authentic and they must give "facts for fact's sake" to be of value in teaching.

PAULINE ROYT, *Secretary*

JUNIOR HIGH SCHOOL GROUP

Dr. Raleigh Schorling has been with the navy as a civilian consultant during the past year or two. The amount of money spent by the services on visual aids has been tremendous. The public schools must increase their budgets for this purpose if they are to see satisfactory results. As chairman of Commission on Mathematics in a Post War World, Dr. Schorling made the following suggestions:

a. Sequential courses in algebra, geometry, etc.; need some changes. Otherwise qualified pupils were found to know little about ratio, slide rule, tolerance, and vectors. Sequential courses should not be geared down but should be used for qualified and college preparatory groups.

b. Need emphasis and drill on fundamental arithmetic and computation.

c. Need for functional competency above computation.

d. Neglected groups should be taken care of by new courses adapted to those who go early into business, industry, etc.; such as mathematics related to physics, industrial arithmetic, general mathematics, consumer mathematics, and refresher courses.

G. P. CAHOON, *Chairman*

JUNIOR COLLEGE GROUP

Dr. M. D. Engelhart presented a paper entitled, "The Roll of the Science and Mathematics Teacher in Meeting the Needs of the Returning Veteran." The paper presented the types of educational experiences offered to the service men through the armed forces institute, and dis-

cussed questions of evaluation of such experiences by colleges and educational institutions. See SCHOOL SCIENCE AND MATHEMATICS for January.

Dr. Bjarne Ullsvik presented a paper "Correlation in the Teaching of First Year Courses in College Mathematics and Physics." The paper will appear in the journal. It stressed common elements and points of dissimilarity in scientific method and nature of proof, the need for generalization in mathematics being based on concrete experiences. Deductive thinking must be preceded by observation and induction. Many examples of correlation were given, the merits and weaknesses of correlation were pointed out, and it was emphasized that correlation of ideas in the minds of the pupils was an emphasis of a somewhat different nature.

Dr. Ingraham read a paper on "Mathematics and Science in a Liberal Education." The emphasis was on liberal education, the education of free men and for a free man. The educational program of a free man should: serve as a basis for fun and enrichment; preserve freedom of choice and specialization; and provide an intelligent, cooperative member of the state. The paper will appear in the journal.

PAUL TRUMP, *Secretary*

THE CONSERVATION GROUP

The Conservation Group Meeting was attended by a total of 48 persons.

Mr. Louis Bromfield continued the development of the general theme presented earlier in the General Session Meeting. He presented the details of specific practices and results of conservation activities on his own farm and ended with the request that teachers teach more conservation to the boys and girls in their charge.

Dr. Jonothan Forman followed with an excellent discussion on the relationship between conservation, especially of the soil, and the health of our people. He emphasized the fact that we need less "pills" and a better diet if we are to become a nation of predominantly healthy people.

Neither of the speakers had completed manuscripts of their talks. Dr. Forman said that his was practically finished and that it would be sent in for publication.

F. OLIN CAPPS, *Chairman*

POSTWAR JOBS IN PUBLIC HEALTH NURSING BOOK ILLUSTRATION REAL ESTATE

Students, school counselors, veterans, war workers, and others interested in postwar jobs will find helpful information in three new six-page leaflets, on *Public Health Nursing*, *Book Illustrations*, and *Real Estate* published by Occupational Index, Inc., New York University, New York 3, N. Y. at 25c each.

Each leaflet covers postwar employment prospects, the nature of the work, abilities and training required, earnings, advancement, advantages and disadvantages of the occupation.

Dr. Elmer K. Bolton, chemical director of E. I. duPont de Nemours & Co., Wilmington, Del., was presented the Perkin medal on January 5 by the American section of the Society of Chemical Industry in recognition of his industrial research accomplishments. He was the 39th chemist to receive this medal, one of the major awards in American chemistry.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any kmown references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1891, 2, 3, 4, 6. *Clarence R. Perisho, McCook, Nebr.*

1893. *Helen M. Scott, Baltimore, Md.*

1891, 3, 5, 6. *M. Kirk, West Chester, Pa.*

1893, 4. *M. Dreiling, Collegeville, Ind.*

1889. *Richard Mayer, Katonah, N. Y.*

1897. *Proposed by J. S. Miller, New Orleans, La.*

A balloon of mass M falls with an acceleration a. How much ballast must be thrown out in order that it may have an upward acceleration a?

Solution by B. Felix John, Pittsburgh, Pa.

1. Weight M, acceleration a (down). The force buoying up the balloon is $M(g-a)$.

2. Weight M', acceleration a (up). The buoying force is $M'(g+a)$.

3. These two forces are the same. Therefore,

$$M(g-a)=m'(g+a)$$

$$M'=\frac{M(g-a)}{g+a}$$

$$M-M'=\frac{M(g+a)-M(g-a)}{g+a}=\frac{2Ma}{g+a}.$$

4. So the weight to be released is $2Ma/g+a$.

Solutions were also offered by Sam P. Morgan Jr., Los Angeles, Calif.; Clarence R. Perisho, McCook, Nebr.; Stanley T. Baker, Riverside, N. J.; and the proposer.

1898. *Proposed by Hugo Brandt, Chicago.*

What was the population of the U. S. when a man by going from New York to San Francisco, a distance of 3100 miles, would shift the center of population by $1\frac{3}{4}$ inches?

Solution by the proposer.

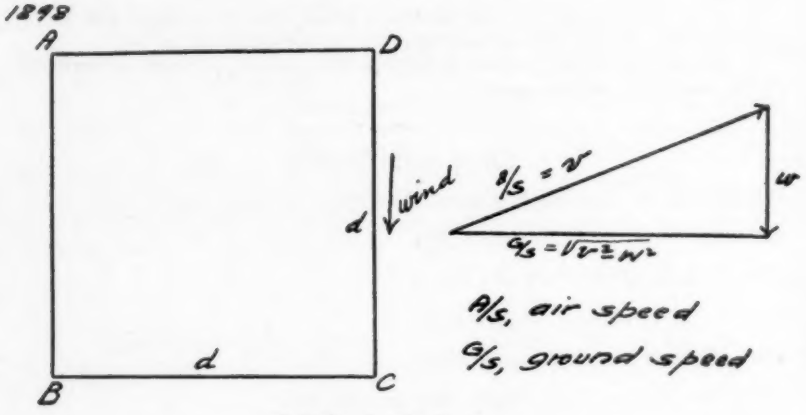
Using the principle of moments about New York, if p is the population, the man's added moment is 3100×5280, and the population added moment is $p\times1\frac{3}{4}\times1/12$. Setting these equal, one obtains

$$p=112{,}237{,}714.$$

A solution was also offered by Sam P. Morgan Jr., Los Angeles, Calif.

1899. *Proposed by Julius S. Miller, New Orleans, La.*

A pilot is to fly a square course. The sides of the square are d miles. His velocity in still air is v miles per hour. A wind blows constantly parallel to a side, its velocity being w mph. Find the time to fly the course. Assume flight parallel to the course, and no time for turns.



Solution by the Proposer.

The velocity along AB, if we start at A and fly as in the diagram, is $V+W$; along CD, $V-W$. To get the velocity along BC or AD, note the velocity or vector triangle. It is $\sqrt{v^2-w^2}$. Hence, we obtain the time to be:

$$\frac{d}{v-w}+\frac{d}{v+d}+\frac{2d}{\sqrt{v^2-w^2}}=\frac{2d(v+\sqrt{v^2-w^2})}{v^2-w^2}.$$

Solutions were also offered by Clarence R. Perisho, McCook, Nebr.; Sam Morgan, Jr., Los Angeles, Calif.; and B. Felix John, Pittsburgh, Pa.

1900. *Proposed by Mae Edwards, Syracuse, N. Y.*

If any determinant vanishes show that the minors of any one row are proportional to the corresponding minors of any other row.

Editor's note: A solution to this problem will not be offered this time.

1901. *Proposed by Orlando Kelley, Romulus, N. Y.*

If a is any prime number larger than 19, show that $a^{18}-1$ is a multiple of 9576.

Solution by Pfc. Roy Wild, Durham, N. H.

$9576 = 8 \cdot 9 \cdot 7 \cdot 19$. Also a^2-1 is a factor of $a^{18}-1$. If $a = 2n+1$, $a^2-1 = 4 \cdot n \cdot n+1$. Either n or $n+1$ is even. Hence a^2-1 and $a^{18}-1$ is divisible by 8, with a odd.

Also by use of the theorem from the Theory of Numbers, If a is relatively prime to n, and if n is prime, then a^{n-1} is divisible by n, it follows that:

(1) a^6-1 which is a factor of $a^{18}-1$ is divisible by 7.

(2) $a^{18}-1$ is divisible by 19.

Also since $a-1$, a, $a+1$ are consecutive integers, one of the numbers $a-1$ or $a+1$ is a multiple of 3. But $a^6-a = (a-1)(a+1)(a^4+a^2+1) = (a^2+1)[(a^3-1)^2+3a^2]$. The second factor is a multiple of 3, hence a^6-1 and $a^{18}-1$ have 9 as a factor.

Hence 8, 9, 7 and 19 are shown to be factors of $a^{18}-1$ under the conditions given.

Solutions were also offered by B. Felix John, Pittsburgh, Pa.; Sam P. Morgan Jr., Los Angeles, Calif.

1902. *Proposed by Rita Dorner, Syracuse, N. Y.*

If α, β, γ are the roots of $x^3+px^2+qx+r=0$ find the value of $\sum \alpha^3\beta^2$.

Solution by Marcellus Dreiling, Collegeville, Ind.

$$\sum \alpha = \alpha+\beta+\gamma = -p \tag{1}$$

$$\sum \alpha\beta = \alpha\beta+\alpha\gamma+\beta\gamma = q \tag{2}$$

$$\alpha\beta\gamma = -r. \tag{3}$$

From (2)

$$\sum \alpha^2\beta^2 = (\sum \alpha\beta)^2 - 2\alpha\beta\gamma \sum \alpha = q^2-2pr \tag{4}$$

$$\sum \alpha \cdot \sum \alpha^2\beta^2 = \sum \alpha^3\beta^2 + \alpha\beta\gamma \sum \alpha\beta. \tag{5}$$

Hence using (1), (4), (2) in (5)

$$\sum \alpha^3\beta^2 = -p(q^2-2pr)+qr$$
$$= 2p^2r-pq^2+qr.$$

Solutions were also offered by B. Felix John, Pittsburgh, Pa.; Walter R. Warne, Marshall, Mo.; Clyde A. Bridger, Salt Lake City, Utah; Sam P. Morgan, Jr., Los Angeles, Calif.; Clarence R. Perisho, McCook, Nebr.; and the proposer.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in his department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below.

From the Lexington H. S. in Ohio solutions to 1899 are offered by Lois Bauer, Maxine Bigler, Rebecca Bogner, Chester O. Brumenshenkel, Helen Clever, Floyd Corwin, Dorothy Fisher, Frederic Sander, Corbin Washington.

The editor regrets that restrictions on publishers due to war conditions prevents the free distribution of magazines to high school pupils who submit problems with solutions as has been the custom for a year. It is to be hoped that high school pupils will continue to make contributions.—The Editor.

PROBLEMS FOR SOLUTION

1915. *Proposed by Helen M. Scott, Baltimore, Md.*

In the loop given by the equation

$$\left(\frac{x}{a}\right)^2+\left(\frac{y}{b}\right)^{2/3}=1,$$

show that the subtangent of the tangent through the point of inflexion is equal to $\frac{2}{3}$ of the abscissa of the point.

1916. *Proposed by Helen M. Scott, Baltimore, Md.*

Find the intersection, within the first quadrant, of the curves

$$\left(\frac{x}{a}\right)+\left(\frac{y}{b}\right)^{1/3}=1 \quad \text{and}$$

$$\left(\frac{x}{a}\right)^{2/3}+\left(\frac{y}{b}\right)^{2/3}=1, \quad \text{when} \quad a=8 \text{ and } b=9/2.$$

1917. *Proposed by Hugo Brandt, Chicago, Ill.*

In a circle of radius r inscribe a regular n-gon with side a, and a regular $2n$-gon with side b. For what n, is $a^2=r^2+b^2$?

1918. *Proposed by Nellie Bishop, Waterloo, N. Y.*

If $a+b+c\equiv 0$, prove:

$$6(a^5+b^5+c^5)=5(a^3+b^3+c^3)(a^2+b^2+c^2).$$

1919. *Proposed by Norman Anning, University of Michigan.*

If a and b are relatively prime positive integers such that

$$a+b=6, 9, 12, 13, \cdots, \text{ Then}$$

$$x^a+x^b+1 \text{ is factorable.}$$

1920. *Proposed by Julius S. Miller, New Orleans, La.*

Find the linear factors of $x^4+y^4+z^4-2x^2y^2-2x^2z^2-2y^2z^2$, and write the polynomial in determinant form.

BOOKS AND PAMPHLETS RECEIVED

CHEMISTRY AND YOU, A TEXTBOOK FOR HIGH SCHOOLS, by B. S. Hopkins, *University of Illinois, Urbana, Ill.;* H. R. Smith, *Lake Forest College Lake Forest, Ill.;* R. E. Davis, *Formerly, Lane Technical High School, Chicago, Ill.;* Martin V. McGill, *Howe Military School, Howe, Ind.*, and G. M. Bradbury, *Montclair High School, Montclair, N. J.* Cloth. Pages xiii+818. 13.5×21 cm. 1944. Lyons and Carnahan, 2500 Prairie Avenue, Chicago, Ill.

FUNDAMENTALS OF CHEMISTRY AND THEIR APPLICATIONS IN MODERN LIFE, by Monroe M. Offner, *Instructor in Chemistry, Abraham Lincoln High School, New York.* Cloth. Pages viii+408. 13.5×20 cm. 1944. The Blakiston Company, 1012 Walnut Street, Philadelphia 5, Pa.

RADIO DIRECTION FINDERS, by Donald S. Bond, *Radio Corporation of America RCA Victor Division, Camden, New Jersey.* Cloth. Pages xii +287. 13×21 cm. 1944. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y.

NAUTICAL MATHEMATICS AND MARINE NAVIGATION, by S. A. Walling *Senior Master R.N. (Ret.)*; J. C. Hill, B.A. *(Cantab.) Education Department, Cambridge University Press;* and C. J. Rees, Ph.D., *Professor of Mathematics, University of Delaware.* Cloth. Pages lx+221. 13×20 cm. 1944. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.00.

GENERAL METEOROLOGY, by Horace Robert Byers, Sc.D., *Professor of Meteorology, The University of Chicago.* Cloth. Pages x+645. 14×22.5 cm. 1944. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $5.00.

MORE ACIDS AND BASES (A Collection of Papers), by David Davidson and W. F. Luder; W. F. Luder, W. S. McGuire, and Saverio Zuffanti; L. F. Audrieth and Therald Moeller; and Robert Ginell. Cloth. Pages vii+79. 12.5×20 cm. 1944. Published by the Journal of Chemical Education, Easton, Pa.

INDUSTRIAL SERIES: MATHEMATICS, by John W. Breneman, C.E., *Associate Professor of Engineering Mechanics.* Prepared under the Direction of the Division of Engineering Extension. The Pennsylvania State College. Second Edition. Cloth. Pages xii+224. 13×21 cm. 1944. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $1.75.

RAINBOW SERIES: ADVENTURES IN SCIENCE WITH JUDY AND JOE, by Harry A. Carpenter, Guy A. Bailey, and Mary Louise Baker. First Grade. Cloth. 92 pages. 14×20 cm. 1939. Allyn and Bacon, 2231 South Park Way, Chicago 16, Ill.

RAINBOW SERIES: ADVENTURES IN SCIENCE WITH BOB AND DON, by Harry A. Carpenter, Guy A. Bailey, and Bernice T. Stroetzel. Second Grade. Cloth. Pages vi+137. 14×20 cm. 1940. Allyn and Bacon, 2231 South Park Way, Chicago 16, Ill.

RAINBOW SERIES: ADVENTURES IN SCIENCE WITH JANE AND PAUL, by Harry A. Carpenter, Guy A. Bailey, Bernice T. Stroetzel, and Ethel Ebrite. Third Grade. Cloth. Pages v+186. 14×20 cm. 1940. Allyn and Bacon, 2231 South Park Way, Chicago 16, Ill.

RAINBOW SERIES: ADVENTURES IN SCIENCE WITH DORIS AND BILLY, by Harry A. Carpenter, Guy A. Bailey, and M. Elizabeth Tuttle. Fourth Grade. Cloth. Pages vi+249. 14×20 cm. 1941. Allyn and Bacon, 2231 South Park Way, Chicago 16, Ill.

RAINBOW SERIES: ADVENTURES IN SCIENCE WITH JACK AND JILL. by Harry A. Carpenter, Guy A. Bailey, and M. Elizabeth Tuttle. Fifth Grade. Cloth. Pages vi+314. 14×20 cm. 1942. Allyn and Bacon, 2231 South Park Way, Chicago 16, Ill.

RAINBOW SERIES: ADVENTURES IN SCIENCE WITH RUTH AND JIM, by Harry A. Carpenter, Guy A. Bailey, Paul E. Smith, and M. Elizabeth Tuttle. Sixth Grade. Cloth. Pages vi+407. 14×20 cm. 1943. Allyn and Bacon, 2231 South Park Way, Chicago 16, Ill.

SHOP JOB SHEETS IN RADIO, BOOK II: SERVICE PROBLEMS by Robert Neil Auble, B.S., A.B., *Instructor in Radio Arsenal Technical Schools, and Supersivor, Signal Corps Radio School, Indianapolis, Indiana.* Paper. Pages vii+128. 21×28 cm. 1944. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.50.

THE FUTURE OF INDUSTRIAL RESEARCH, by Thomas Midgley, Jr., *President and Chairman of the Board, American Chemical Society.* Paper. 20 pages. 13.5×20 cm. Standard Oil Company (New Jersey), Room 1610A, 30 Rockefeller Plaza, New York 20, N. Y.

VOCATIONAL-TECHNICAL TRAINING FOR INDSUTRIAL OCCUPATIONS. Report of the Consulting Committee on Vocational-Technical Training appointed by the U. S. Commission of Education. Paper. Pages xxii+307. 14×23 cm. 1944. Federal Security Agency, U. S. Office of Education, Washington 25, D. C. Price 40 cents.

THE INSTITUTE OF INTERNATIONAL EDUCATION 1919–1944: ITS AIMS AND ACHIEVEMENTS DURING TWENTY-FIVE YEARS. Pamphlet Series No. 9. September 1, 1944. 40 pages. 15×23 cm. Institute of International Education, 2 West 45th Street, New York 19, N. Y.

INSTITUTE OF INTERNATIONAL EDUCATION. Twenty-Fifth Annual Report of the Director. 73 pages. 15×23 cm. October 1, 1944. Institute of International Education, 2 West 45th Street, New York 19, N. Y.

GENERAL EDUCATION BOARD, founded by John D. Rockefeller in 1902. Annual Report 1943. Paper. Pages ix+108. 14.5×22 cm. General Education Board, 49 West 49th Street, New York, N. Y.

SCIENTISTS OF TOMORROW. Essays and Report of the Third Annual Science Talent Search for the Westinghouse Scholarships 1944. Paper Pages vi+136. 11×18 cm. Science Clubs of America, 1719 N Street. N.W., Washington 6, D. C.

TALKS: A QUARTERLY DIGEST OF ADDRESSES PRESENTED IN THE PUBLIC INTEREST BY THE COLUMBIA NETWORK. Paper. 56 pages. 14×20.5. 1944. Columbia Broadcasting System, Inc., New York, N. Y.

BOOK REVIEWS

THE RAINBOW SERIES—ADVENTURES IN SCIENCE, by Harry A. Carpenter and others. With Judy and Joe, First Grade, 94 pages. With Bob and Don, Second Grade, 141 pages. With Jane and Paul, Third Grade, 190 pages. With Doris and Billy, Fourth Grade, 253 pages, With Jack and Jill, Fifth Grade, 318 pages, With Ruth and Jim, 411 pages. Allyn and Bacon, 2231 South Park Way, Chicago 16, Illinois.

This is one of the most attractive, interesting and alluring sets of readers ever put on the market. Each page is designed to give a new lesson in English, art and science. By the time he has completed the sixth grade the child will know many of the common mysteries of science that are the perplexing puzzles of adult life; he will have acquired the language of an educated adult; he will be able to think and talk with intelligence and precision about growing fruit, air travel, rich and poor soil, beautiful gardens and lawns, devastating insects, distant stars, and hosts of other science topics important and interesting to everyone. He will acquire all

this information and the ability to express his ideas in clear and concise form without realizing that he has ever had a lesson to prepare. He will have established the habit of looking for information about plants, clouds, rocks, animals, etc. from the objects themselves as well as from other books and magazines, and will no longer be distressed and confused by ignorant charms and superstitions still so common in many communities in both country and city. Practically all of the first book is in verse about a beautiful and instructive colored picture covering half of each page. Every word appears in the Buckingham-Dolch *Combined Word List*, and most of them in Gates's *Reading Vocabulary for Primary Grades*. As each new book is taken up color becomes less prominent and the reading content increases, but colored pictures are used throughout the set. This is the best set of elementary science books ever offered. But they are not only science books. The language is perfect and the art work of high quality. The exercises consist of things to draw, to make, to tell, to do. Work is provided for the dullest child and the brightest one, and no one realizes while doing it that he is preparing a lesson. Just give the youngster a chance with the help of this set of books. He will make progress.

G. W. W.

ESSENTIAL MATHEMATICS, by William D. Reeve, *Teachers College, Columbia University*. Paper bound. iv+284. 1.5×16.7×25.2 cm. 1943. The Odyssey Press, Inc., New York City. Price $1.32.

The essential mathematics, in accordance with the title, covers the fundamental arithmetical skills, such informal geometry categories as intuitive, experimental (paper cutting), observational, and fundamental geometric constructions.

The simpler elements of algebra are organized around the formula, the equation, the graph, and directed numbers. Indirect measurement is accomplished through the medium of scale drawings and numerical trigonometry.

JOSEPH J. URBANCEK

SHORT COURSE IN COMPUTATION (Principles of Arithmetic, Practice, Diagnostic Tests, and Remedial Exercises), by Clifford B. Upton. Paper bound. 0.9×19×24 cm. 1944. American Book Co., Chicago.

This book covers the fundamental operations of arithmetic with detailed explanations of the difficult topics. It aims at such flexibility as permits its use with a class or for individual use where each student progresses at his own pace; and is also prepared for self instruction. Diagnostic tests are distributed throughout the book to enable the teacher to discover student weaknesses.

JOSEPH J. URBANCEK

GUIDE TO THE EVALUATION OF EDUCATIONAL EXPERIENCES IN THE ARMED SERVICES

One of the most valuable and practical tools to aid in the educational readjustment of veterans has just been issued by the American Council on Education. This is a *Guide to the Evaluation of Educational Experiences in the Armed Services*, compiled for the Council under the direction of George P. Tuttle of the University of Illinois with the cooperative support of nineteen regional and national accrediting associations. The loose-leaf handbook will be indispensable for any institution which expects to evalu-

ate fairly the educational experiences of men and women who served in the military forces. The armed forces have themselves ordered more than 10,000 sets of the book.

George F. Zook, president of the Council, called the *Guide* "the most valuable single contribution to assure fair treatment of returning veterans." He said, "In a very real sense, this is a qualitative catalogue for civilians describing and measuring the widespread, varied and complex educational and training programs of the Army, Navy, Coast Guard and Marine Corps."

The handbook has been in preparation throughout the spring and summer. The first section of 271 pages includes: (1) an introductory statement about the general problem; (2) information concerning the United States Armed Forces Institute, the Marine Corps Institute, the Coast Guard Institute, and the off-duty program of the Navy; (3) evaluation in terms of secondary school and college credit of correspondence courses offered by the Armed Forces Institute, the Marine Corps Institute, and the Coast Guard Institute; and (4) summaries and recommendations in terms of secondary school and college credit of 166 service schools and courses in the Army, Navy, Marine Corps, and Coast Guard. These summaries indicate for each school or course the location, length, objective, plan of instruction, description of subjects, and recommendations as to credit. This section of the *Guide* also contains statements of policies of institutions respecting credit for the CAA-WTS program and for the Naval Flight Preparatory Program.

Future sections of the *Guide* will contain a discussion of the various examinations prepared by the Armed Forces Institute, lists of such examinations available, credit values of the examinations and critical scores; evaluation of further correspondence courses offered by the Armed Forces Institute, and the Coast Guard Institute; a discussion of and recommendations concerning self-study service training courses in the Navy; and summaries and recommendations concerning a large additional number of formal service schools and courses.

Subscriptions to the *Guide* are $2.00 a set. Orders should be mailed to 363 Administration Building, Urbana, Illinois. The first section of the *Guide* will be mailed immediately upon receipt of orders. Subscribers will receive not only material now ready but also new material which becomes available up to January 1, 1945. The staff will continue to prepare material until that date.

TELEVISION SEEN READY AS SERVICE TO PUBLIC

The stage is set and ready, technically, for the beginning of a regular television broadcasting service to the public, E. W. Engstrom, Research Director of RCA Laboratories, said in the keynote address at the First Annual Conference of the Television Broadcasters Association.

The state of readiness of television, as he sees it, is evaluated "in cold engineering terms," and he added, "Those who feel that television is not ready and should, therefore, be delayed, must obviously not use the same clear spectacle lenses of engineering appraisal through which I so clearly see this situation."

"Now, as at earlier times, there are those who raise their voices in opposition, but today the industry in regard to television is as nearly united in its recommendations as it is practical to expect," said Mr. Engstrom. "Those who oppose, speak of the need of further improvement and refinement and of the necessity, therefore, to use channels in a higher frequency portion of the radio spectrum."

The challenges of war have revealed certain of the weaknesses of our science program. However, if we accept unchallenged the criticisms of various branches of the armed forces and of industry as to our weaknesses, we make the error of permitting someone who is not a student of the problems of education, or even of the problems of society, to attempt to determine our course.—J. S. RICHARDSON.

CONTENTS FOR MARCH, 1945

Central Association Has a Job for All—*Walter H. Carnahan* 199

Chauncey E. Spicer—*Robert L. Price* 200

Trends, Deficiencies, and Challenges Related to General Science—*J. S. Richardson* 202

Drawing with Ruler and Paper—*Adrian Struyk* 211

Aircraft Instrumentation—*W. W. Davies* 215

The Motion Picture as an Aid in Geographical Instruction—*William M. Gregory* 223

Induced Current Demonstration—*F. W. Moody* 229

The Chemistry Program at East Technical High School—*E. Griffin Pierce* 231

Some Notes on Behavior—Part One—*John P. Wessel* 242

The Preparation of Teachers of General Mathematics—*G. H. Jamison* 249

Science Teaching and Science Clubs Now and Postwar—*Watson Davis* 257

Square Root—*A. R. Jerbert* 265

Attitudes Toward the Mathematics Curriculum and Post-War Planning—*Maurice L. Hartung* 273

Mathematics in Weather Forecasting—*John G. Breiland* 279

Problem Department—*G. H. Jamison* 282

Books and Pamphlets Received 289

Book Reviews 290

You Should Use . . .
ths Best Science Texts Available

HEALTH FOR YOU Crisp
A new high school text stressing correct living as the foundation of good health. $1.80 list

MODERN-LIFE SCIENCE Carleton and Williams
Designed to meet the needs of non-college physical science classes. $2.40 list

MODERN-LIFE CHEMISTRY Kruh, Carleton, and Carpenter
Features unit-problem organization with simple, clear presentation. $1.92 list

PHYSICS WORKBOOK Buell and Schuler
This combination workbook and laboratory manual is now revised and thoroughly up to date. $1.20 list

SCIENCE IN MODERN LIFE SERIES Smith and Trafton

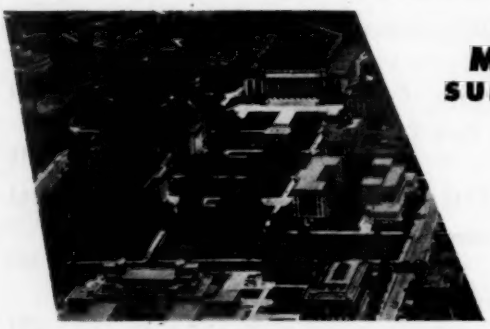
Exploring Science—grade 7—$1.40 list
Enjoying Science—grade 8—$1.60 list
Using Science—grade 9—$1.80 list

All prices subject to usual school discount

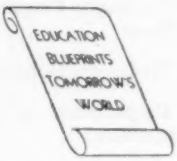
Write for further information or examination copies

J. B. Lippincott Company

Philadelphia
Chicago—New York



MINNESOTA
SUMMER SESSION



IN ADDITION to more than 750 subjects of study covering all fields of educational and scientific interest, especial emphasis is being placed on wartime as well as post-war educational needs. A teaching staff of 600 persons including educators of national and international reputation—plus the splendid facilities of great libraries and laboratories—offer outstanding opportunity for both graduate and undergraduate study. There will be special courses and workshops for teachers in primary, secondary and higher education. Counseling facilities for returning veterans.

First term registration, Monday and Tuesday, June 18 and 19. Second term registration, Monday, July 30.
Write now for complete bulletin. Director of Summer Session, 752 Administration Building.

UNIVERSITY OF MINNESOTA
MINNEAPOLIS 14 MINNESOTA
75th Year of Service